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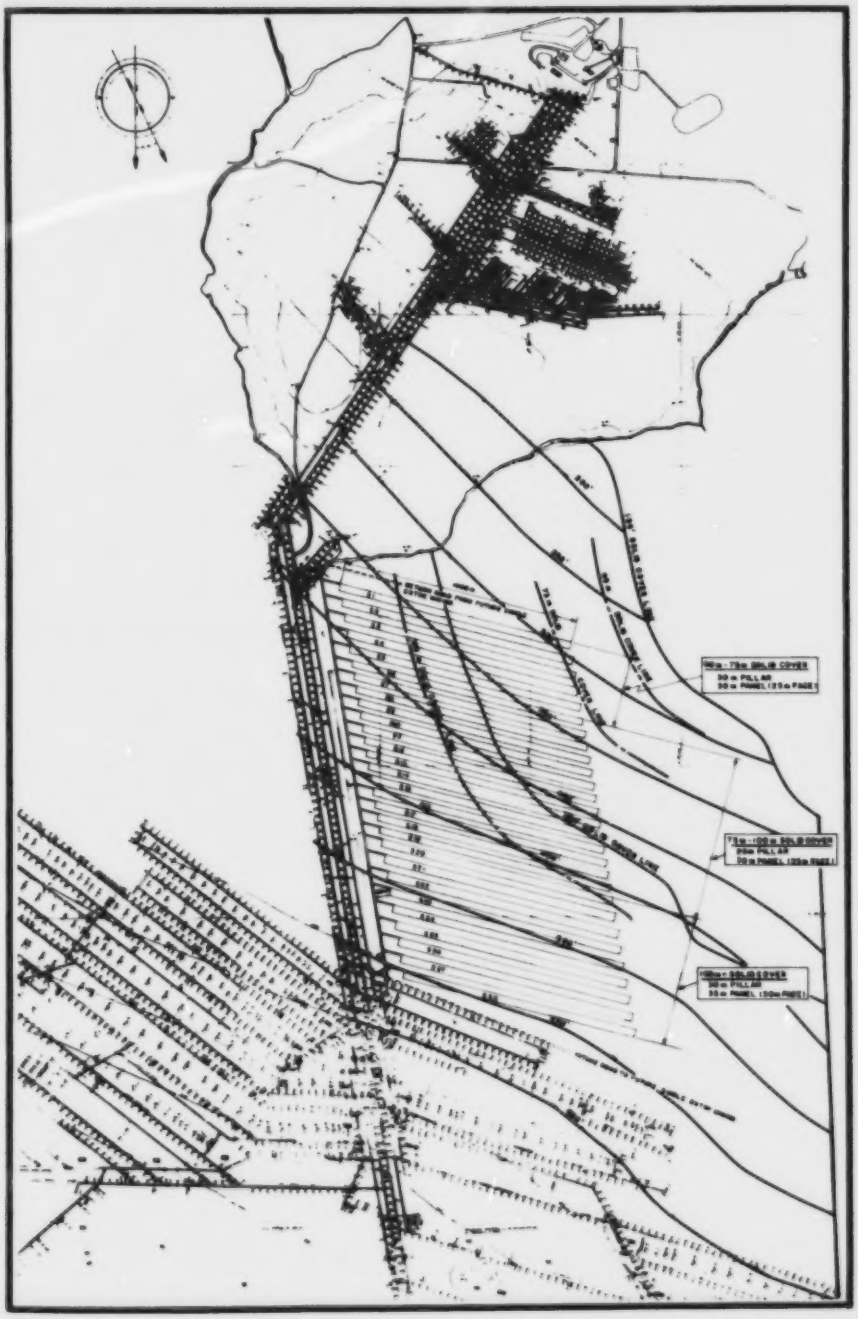
SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS



FINAL REPORT

BY

MONENCO CONSULTANTS LIMITED

MARCH 1988

VOLUME I

A REVIEW REPORT ON THE POSSIBLE APPLICATION TO BROKEN WORKINGS IN THE SYDNEY COALFIELD.

WORK ON THIS PROJECT WAS CONDUCTED UNDER THE AUSPICES OF THE DEPARTMENT OF ENERGY , MINE AND RESOUR S

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SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS FOR BROKEN WORKINGS A REVIEW REPORT ON THEIR POSSIBLE APPLICATION IN THE SYDNEY COALFIELD NOVA SCOTIA. CANADA.

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1988-03-25
DSS 8374-1/4700

Mr. G. Haslett
Scientific Authority
CANMET
Cape Breton Coal Research Laboratory
210 George Street
SYDNEY, N.S.
B1P 1J3

Dear Mr. Haslett:

Re: Single Entry Short Longwall Retreating Systems
DSS Ref 03SQ 23440-7-9022

We have pleasure in submitting our final report for the above project, in ten bound copies, each of which contains an executive summary in English and French.

The report, which includes the comments made during the review of the draft report, comprises seven parts. Part 1 describes the background to the study; Part 2 deals with the study methods; Part 3 describes the existing CBDC mines and Part 4 gives a description of the Single Entry System and of existing and previous applications; Part 5 presents the design guidelines for the application of the system to the Prince Mine with our conclusions and recommendations being given in Parts 6 and 7 respectively. We have also included in the Appendices, as a separate volume, references, selected equipment brochures and strata control calculations.

We wish to acknowledge the invaluable assistance we have received from Golder Associates (Strata Control) and Obed Coal (Equipment). We have found the work on this project extremely interesting and trust that the report will be to your satisfaction. We shall be pleased to answer any questions arising from the report.

PROFESSIONAL ENGINEER
IAN R. MUIRHEAD
ALBERTA

Yours very truly,

MONENCO CONSULTANTS LIMITED

I.R. Muirhead, P.Eng
Manager, Mining

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EXECUTIVE SUMMARY

1.0 INTRODUCTION

This report was commissioned by the CANMET Cape Breton Coal Research Laboratory in Sydney, N.S. Its objective was to review the possible application of single entry short longwall retreating faces as a practical and productive method of mining under certain circumstances and conditions that prevail within the Sydney Coalfield in Nova Scotia Canada.

2.0 STUDY METHODS

Visits were made to CBDC offices and operating mines, and the Mines Inspectorate to obtain data on the conditions and practices governing the operations in the Sydney Coalfield.

Data on Single Entry Short Longwall Retreating (SESLR) Systems was then resourced by:

- Literature search of eight international mining data bases, and the international mining section of the CISTI Library.
- Visits to mines in U.K., Belgium, West Germany and talks with Mines Inspectorates.
- Discussions with manufacturers of equipment used in SESLR systems.
- Questionnaire to mines operating or which used the single entry system, and to coal mining research organizations in U.K., U.S.A., FRG and Australia.

The conditions at the CBDC Prince, Lingan and Phalen mines were evaluated and suitable sites for use of the SESLR system were selected. The requirements of the SESLR system were identified including critical features and the data from the operating mines and other sources collated. An initial CBDC site was selected and design guidelines were developed.

3.0 CAPE BRETON DEVELOPMENT CORPORATION MINES AND POTENTIAL SITES

The three operating undersea coal mines of CBDC in Cape Breton (Figure 1) were described including details of operating longwall faces and development headings at each mine.

The oldest mine is the Lingan Mine which started production in 1972. This uses the longwall advancing system and is designed to produce 1.45 Mt per year of clean coal from three 222 m long longwall faces mining the 2.0 m thick Harbour Seam. Current workings are now 4 kms beyond the shoreline dipping at 8°. The mine is very gassy with methane emission rates up to 30 m^3/t on the longwall panels. This is reduced considerably through a very effective methane drainage system.

CBDC's newest mine, the Phalen Mine, is located immediately adjacent to the Lingan Mine, and is mining the Phalen seam (1.8-2.45 m) some 180 m below the Lingan Mine workings. The mine commenced production in 1987 and is designed to produce 1.6 Mtpa from two retreating longwall faces (presently 150 m long). The seam dips at 12° with methane emission rates of the order of 15 m^3/t. This rate is expected to increase as operations move down dip.

The third operating mine, the Prince Mine, is located to 25 kms NW of the Lingan and Phalen mines. Mining commenced in 1976 under the Pt. Aconi peninsular using rooms and pillar methods. This was abandoned due to extremely poor floor conditions, and the mine was redeveloped 4 kms from the portal as a longwall mine using short (113 m) retreating faces. The mine is extracting the Hub seam (1.8-2.45 m) producing 35,000 ROM tonnes per week from a single longwall face. The seam dips at 2°-3° and has a low methane emission rate (0.26 m^3/t).

Remnant areas potentially suitable for the application of the SESLR system were identified at each mine, but the largest and most suitable area, by virtue of low methane emission, gradient and general mine conditions and standards was at the Prince Mine between the existing longwall workings and the shoreline (Figure 2).

4.0 SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

Single entry short longwall retreating is defined as a short longwall face serviced by only one roadway, [not as the Americans, S. Africans and Australians define it--a longwall with a single roadway at each end].

The Single Entry Short Longwall Retreating System has been used, in one form or another, since 1980 for the mining of isolated or broken areas of coal, for mining by partial extraction where subsidence has to be eliminated or minimized, and as a major production system.

Some 17 mines in U.K., West German, Australia and Morocco have used the system. Currently, there are four mines in U.K., one in West Germany, one in Morocco and one in Australia operating the system, while a further five additional mines (three in U.K., one in FRG, one in Hungary) are known to be considering the system.

The Wistow mine in the U.K. has now worked more than 15 such faces; the Stolzenbach mine in W. Germany is now on its 22nd face, and both the Sherwood and Mansfield mines in the U.K. expect to work many faces as they are used to mine coal by partial extraction under urban centres.

Table 1 summarizes the main details of installations at the 17 mines.

The SESLR system has been developed with a basic format and a number of layout alternatives and equipment variations. These are:

- Basic System - Total Auxiliary Ventilation
- Alternative #1 - Single Through Roadway with Auxiliary Face Ventilation
- Alternative #2 - Single Through Roadway with Face Return Behind Supports Through Waste
- Variant #1 - Single Machine for Roadway Development and Mining

Of the 17 mines which have worked the SESLR system, only two have not used the Basic System. Alternative #1 was proposed for the Rheinland Mine (FRG). Alternative #2 was specified for the Gretley Mine (Australia) which commences operations in June 1988. Variant #1, as far as can be determined has not yet been applied.

The basic single entry system comprises a single roadway driven from main or district roadways to a predetermined distance, with a short longwall face developed off this single roadway. Figure 3 shows a typical layout. The length of the single roadway is usually dictated by ventilation considerations and the size of the area to be worked. The single 'blind' face is then retreated back to the main or district roadway with the ventilation of the gate roadway and face being maintained by auxiliary ventilation systems. The roadway is driven using conventional continuous miners, roadheaders or similar machines, which are also used to develop the face line. The face is then equipped with powered supports, shearer, chain conveyor, with ventilation ducting incorporated into the conveyor furnishings, and monitoring and communications systems. A stage loader and belt conveyor are located in the roadway together with special powered supports at the face/roadhead interface. A control station is located on the stage loader incorporating the monitoring and communications reporting units. In a number of recent installations, the face AFC and stage loader have been replaced by a single curved chain conveyor. Ventilation is usually forcing with fans located adjacent to the face and outbye the single entry. Materials transportation is by either locomotive or rope haulage using rail bed materials cars or by free steered vehicles, (FSV). Most systems are very similar, 30-50 m face length and up to 1000 m panel length, but their safe and efficient operation is very dependent on the considerable amount of planning and attention to detail that went into their design, establishment and operation.

In alternative #1, the short face is still maintained at right angles to the single roadway and is ventilated using auxiliary systems. However, the single roadway is no longer a 'blind' end, but is maintained throughout its length. It is connected to intake and return roadways so that mainstream through ventilation is maintained. A solid pack (pump pack) is placed at the roadside immediately behind the face powered supports to ensure that the roadway behind the face is kept in usable condition.

In alternative #2, the short blind end face is maintained at right angles to a single through roadway, or off one of a pair of development headings forming a main ventilation circuit. There are, however, no auxiliary ventilation systems used, as the powered supports along the face and across the roadway are sealed so as to prevent leakage through them. The ventilation current thus flows up the roadway, is deflected along the face, and passes by the last support in the blind end and returns behind the supports to the roadway, and returns out of the mine. This alternative relies on maintaining an airway through the waste area.

Variation #1 is a modification to the basic system whereby the same machine is used to drive the roadway, open up the face line and mine back the retreating face. These are special purpose machines of the types made by Eickhoff (ESA 60, ESA 150, ESA 300); Westfalia (VME and derivatives) and DOSCO (In-Seam Miner - ISM 2000, ISM 3000).

The application of the Single Entry system has to be approached with caution since its use adds a considerable element of risk when compared to either a single drivage, or a conventional two entry longwall face.

There are several aspects of the single entry system which are critical to the safe and successful operation of a single entry face. These include:

- Ventilation
- Support
- Methane and Dust Control
- Monitoring
- Communications
- Access
- Frictional Ignition Control
- Rates of Retreat and Materials Handling
- Manning Levels

These are discussed in detail in the report in Part 4.2, and represent the main features which have to be addressed in developing the design and obtaining approval for the use of the single entry system of mining.

As at the writing of this report, there are seven mines known to be working the Single Entry Short Longwall Retreating System in its basic or alternative forms. These are:

- Wistow Mine - UK
- Sherwood Mine - UK
- Mansfield Mine - UK
- Allerton Bywater Mine - UK
- Stolzenbach Mine - FRG
- Gretley Mine - Australia
- OCP Phosphate Mine - Morocco

A number of underground coal mines in the United Kingdom have used the single entry system. Some of these mines have since closed (*) and few details are available.

In chronological order, they are:

1980(-85)	Whitwick*
1980	Wath*
1980	South Kirkby
1982	Measham
1983	Ledston Luck*
1983	Royston Drift
1983	Pye Hill*
1984	Cadley Hill
1987	Bevercotes

A number of mines in various parts of the world are considering the use of the single entry system for either the recovery of remnant areas of coal and coal pillars or as a production system.

These include:

- o Norgrad Mine - Hungary
- o Rheinland Mine - FRG
- o Bagworth Mine - U.K.
- o Ellington Mine - U.K.

In addition to the summary details given in Table 1, more detailed descriptions of all these installations are given in Parts 4.3, 4.4 and 4.5 of the report.

It is, however, worth noting that the record production and productivity from a single entry short longwall face is held by the Wistow Mine of British Coal which, from a 35 m long face manned by 5 men per shift, produced 26,928 t in 15 shifts at a face OMS of 360 t per manshift. The 2.1 m high face retreated 180 m in the week.

One of the variations possible within the basic single entry system is to use one cutting machine to drive the single entry roadway and the face line, and then mine the short face on the retreat. Although this principle has not yet been tried in practice, three manufacturers can provide equipment which should be capable of fulfilling this requirement.

The applicable equipment is supplied by:

- o DOSCO (UK) - In Seam Miner - ISM 2000
  - ISM 3000
- o Eickhoff (FRG) - ESA Shearer Loader - ESA 60
  - ESA 150
  - ESA 300

- Westfalia (FRG) - Mining & Heading Machine - VME

This equipment is generally of lower power than the conventional shearer and the results when used as a mining machine on short faces reflect this with best weekly outputs of the order of 14,000 t.

The selection of either a conventional shearer, or heading/face machine for mining the single entry face is dependent on three major factors which are site specific.

- Evaluation of production level expected from the retreating face.
- Methane emissions and need for ventilated (RAC) drums, (not available on heading machines).
- Capital and equipment availability.

These are decisions that can only be made by the mine contemplating using the single entry system.

A comparison between a single entry face equipped with a conventional shearer, and one equipped with an ESA or VME machine shows very little difference as can be seen in Table 2.

The advantages in using one machine for all drivage and mining functions are:

- Considerable saving in time and cost since no need to dismantle and withdraw heading equipment.
- Better utilization of equipment.
- Face can be equipped with powered supports whilst being driven, as drivage machine does not have to be withdrawn on completion.
- Capital cost lower as only need one machine instead of two different ones.

The disadvantages are:

- Production rates per unit of face length, per powered support, or per unit of capital cost are lower.
- The combination has not yet been operated in any mine in Europe, North America or Australia.

- Mine operator's preferences are almost always to use a separate and different machine for the mining of the short retreating face.

- Heading machines do not generally have such features as ventilated extraction drums for the control of dust and ventilation of methane around the cutting drum.

Guidelines are given in Part 5 of the report for the design, layout, equipping and operation of single entry faces in the selected reserve area at the Prince Mine. These guidelines present specifications for the equipment which it is felt will provide the safest and most efficient system, however it is realized that the initial faces used to prove the system will probably be based to a greater extent on equipment currently available to and within CBDC mines.

Comments are included on the effects the use of existing equipment may have on performance and safety.

The final design, layout and equipping of a single entry face will require a more detailed evaluation involving a greater involvement of the staff and engineers of CBDC HQ and the Prince Mine than is possible or required by this study.

The critical aspects of a single entry system for the Prince Mine are discussed in detail in Part 5 of the report. These are summarized below and include:

- Selected Mining Area
- Basic Layout
- Support
- Development Equipment
- Production Equipment
- Ventilation
- Manpower
- Production and Productivity
- Face Installation, Salvage & Transfer

Selected Mining Area

Only the Prince Mine was considered initially suitable for the possible application of the single entry system (methane emissions being too high at Lingan and Phalen Mines) and the area between the longwall workings and the shoreline, west of the main deeps was considered to contain the best conditions of the available areas. Within this designated area, a block 1000 m x 1600 m was selected for the initial mining which was also as close to the existing mine access and services as was practical.

Basic Layout

Prior to determining the face and panel geometry, an assessment was made of the local geology, rock mass quality, intact rock strength and the prevailing stress regime.

The area selected for single entry mining at Prince Mine lies between 55 m and 140 m below the seabed, thus 'surface' subsidence control was the primary design criteria. CBDC design policy limits the maximum strain at the seabed to 8.5 mm/m. This was adhered to in this study, as was the regulatory requirement of a minimum depth of solid cover over any extraction area.

Strain profiles were developed, with the aid of a computer program provided by the Cape Breton Coal Research Laboratory, for varying panel and pillar widths and depths of solid cover. These showed that panel width and cover depth were the critical parameters. Similarly, stress profiles were developed for pillars between adjacent faces. These resulted in the following dimensions for the single entry system.

Depth of Solid Cover (m)	Panel Width (m)	Face Length (m)	Pillar Width (m)
60 - 75	30	25	30
75 - 100	30	25	20
+100	35	30	30

The overall extraction ratio in the block is 56% representing some 2.75 Mt of coal from 28 single entry faces.

The following factors were considered when laying out the single entry panels.

- the depth of cover above the coal;
- the dip of the seam;
- the presence or otherwise of seatearths;
- the roof type.

In determining the direction of mining, the most important factor to be taken into account, is the direction of the seam gradient and the desirability, for assisting with methane control, of working the face retreating to the dip. This has the effect of helping to retain the methane in the waste area. Similarly, in assessing which direction the face should be off the roadway, to the rise or dip, several factors were taken into account. These include:

- ventilation and methane control,
- ease of face development,
- direction of coal transportation,
- potential support and stability problems at face/roadway interface.

Methane control is by far the most important, so faces were kept to the dip side of the roadway, such that methane migrates to the roadhead area where it can be dealt with more readily than if it is at blind end of the face. Roadway conditions are also likely to be better if the waste area is to the dip side.

The primary restrictions on the length of panel which can be mined are based on the length of single entry that can be effectively ventilated, and the need, for safety reasons, to have no intermediate belt conveyor drives and transfer points in the single entry roadway. Experience at Prince Mine has shown that the maximum single roadway length that can be safely ventilated is of the order of 1000 m. For the purposes of this study, this has been taken as the panel limit.

The roadway width is dictated by the width necessary (5 m) to accommodate the equipment in the roadway (especially in the roadhead area) and by strata control considerations. Strata control considerations show that this 5m width is acceptable provided the coal sides of the roadway are kept tight to the support legs. Since this is not always possible, it is considered that safety would be considerably enhanced if rock bolts are utilized between the steel sets.

Figure 4 shows the proposed layout of the single entry mining area based on the above criteria.

- <u>Support</u>

More stringent requirements for support in a single entry system are necessary due to the single access to the working face and the consequences of any ground instability in this access and on the face.

Considerations of stress, rock quality, the presence of an active mining area, and conditions and standards at the mine and the need to provide an 'active' support system showed that the existing steel set support system was adequate, when properly installed at 0.9 m intervals in a correct width roadway, and also that a rock bolt,steel strap and mesh system at 1.0 m centres would also provide safe support. However, it was recommended that, in the roadways, initial

development be carried out using steel sets at 1.0 m intervals with rock bolts between the sets, and that, as experience is gained, the steel set spacings should be increased.

Conditions on the existing longwall faces at Prince indicate that the 320 t shields provide a support load density of 59 t/m^2. Calculations showed that the required density in the single entry area was 26 t/m^2. It was recommended that the existing shields be used on the single entry face but with lower setting and yield pressures.

- Development Equipment

The study recommends that the Westfalia VME Roadheader equipped with powered supports be used to drive the single entry roadway and face line because it enables cutting and support setting to be undertaken simultaneously and especially because it produces vertical sides to the roadway of fixed cutting width thus permitting tight control of the roadway configuration. All other equipment should be the same as that required to service the retreating face.

- Production Equipment

Short single-ended-ranging-drum shearers mounted on a roller curve AFC with a ventilation duct through the AFC furnishings are recommended for the face. The gate conveyor should be of the modular in-seam type with automatic loop takeup and belt reel station with 100 m of belt storage. The powered support pump station should be remote to the single entry and materials handling should be by free steered vehicles (FSV).

Every effort must be made to keep the design simple, to use the least number of items of equipment and keep the equipment in the single entry roadway and face to a minimum.

- Ventilation

A forcing ventilation system is proposed using a 90 kW primary fan and a secondary 37.5 kW fan, the latter at the roadhead. These should be able to supply a minimum of 5.0 m^3/s to the blind end of the face, and at the methane emission rates presently encountered at Prince (0.26 m^3/t) should safely dilute the methane to about 0.40% on the face when production rates are around 1330 t/shift from a 25 m long face.

Extensive monitoring and control are necessary as is shown on Figure 5.

- Manpower and Production

Normal shift requirements for a single entry face are five, namely:

Shearer	2
Supports	1
Roadhead	1
Supervision	1

Electrician and mechanic are shared with the adjacent roadway drivage as are the FSV materials handling crew.

Assuming that the face shearer is a 300 kW machine and that a machine cutting availability of 40% of an 8-hour shift is realistic, the face should produce 1330 t/shift, (3390 t/day, 17950 t/week), retreating at 14.6 m/shift, (43 m/day or 216 m/week).

Peak production rate is 990 tph and the expected face and district outputs per manshift are 169 t/MS and 147 t/MS, respectively.

- Face Installation, Recovery and Transfer

Experience indicates that, in conditions present at Prince Mine, this is best accomplished using FSV units and that the total time required should not exceed two weeks.

- Regulatory Aspects

The relevant regulations that affect the approval and application of the single entry system are discussed in the report (Section 5.11).

- Costs

Costs benefits were assessed on a comparison basis using data provided by CBDC and equipment suppliers.

Capital equipment additions ($0.75M) and deletions ($3.0M) comparing a single entry face with a current retreating face at Prince, show a capital cost saving of the order of $2.25M.

Operating costs reduce for single entry faces due to higher productivity. Power and material costs are considered to be similar for the two faces. Discounting any changes in bonus, and taking into account manpower and output, operating cost savings of $0.70/t appear likely. ($630,000 per year).

- Summary Specification

  Table 3 summarizes the specifications of the criteria and equipment recommended for use in the single entry short longwall retreating system at the Prince Mine.

CONCLUSIONS

This study has reviewed the application of single entry short longwall retreating (SESLR) systems used or in use at underground coal mines around the world, and the conditions and operations at the CBDC mines.

The following conclusions can be drawn.

1. The SESLR system has been used for over 8 years, and in 16 of the 17 mines where it has been or is being used, it has proved to be a safe and efficient method of working.

2. The SESLR system can be used for the mining of broken workings or remnant areas, for partial extraction mining and as a regular production system.

3. The successful and safe operation of the SESLR system requires the application and maintenance of the highest standards of ventilation and support, and also of conventional mining practices.

4. Comprehensive monitoring of the environment in the panel is required.

5. The SESLR system should be designed with the least number of components possible, and be kept as simple as possible.

6. The number of items of equipment in single entry roadway should be kept to the minimum.

7. Control of methane is the most important factor affecting the safety of the system.

8. Support of the single entry roadway, and the roadway face interface is also critical.

9. The SESLR system can produce coal at high productivities and make positive contributions to mine profits.

10. The SESLR system places great demands on the development operations, and requires that the development is organized, operated and monitored to the same if not greater level as the face mining operations.

11. The strata conditions and working standards are sufficiently good, and the methane emission levels sufficiently low at the Prince Mine, that the SESLR system can be applied in the designated areas with every expectation of a safe and successful result.

12. Although there are remnant areas of coal at both the Lingan and Phalen mines, conditions, standards and methane emission levels are such that, at this stage, these two mines cannot be considered for the use of the SESLR system.

13. The SESLR system can be worked with either separate machines for both roadway/face development, and for retreat mining, or with a single machine for both functions. In the latter case, which has not yet been tried anywhere, lower production levels can be expected from the retreating face.

RECOMMENDATIONS

1. The single entry short longwall retreating system should be applied at Prince Mine in the designated area between the shoreline and the longwall workings west of the main deeps.

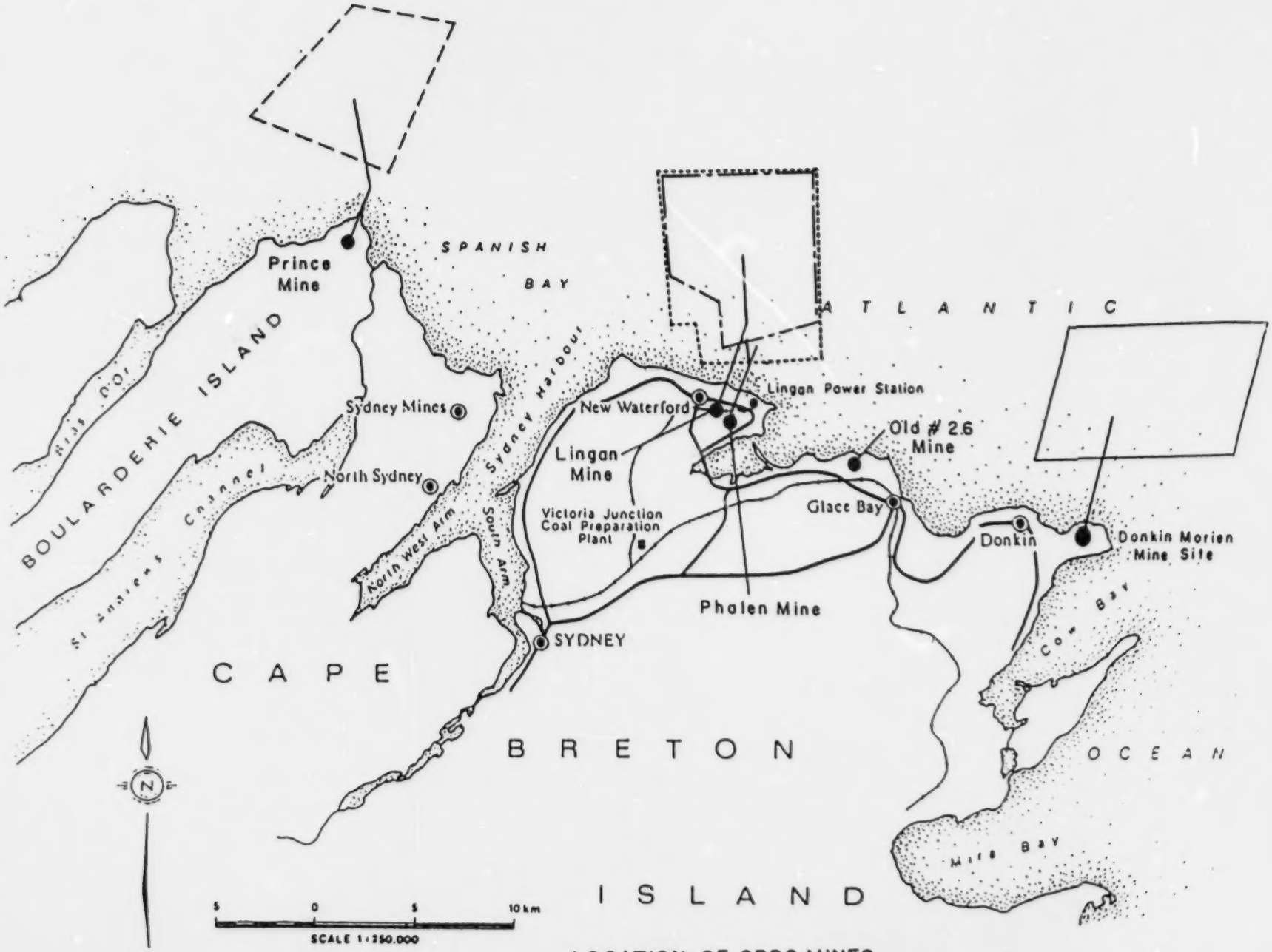
2. A detailed design for the complete system should be prepared by Prince Mine and CBDC Glace Bay staff based on the guidelines presented in this report and modified as necessary to meet regulatory conditions and equipment availabilitiies. This should be reviewed before implementation.

3. The initial operations should be based on the use of a heading machine for the drivage of the roadways and face line, with a shearer mining the retreating face. Once the system has been successfully proven, consideration should be given to the use of a single machine for both development and mining.

4. Roadway supports should include the use of rock bolts (Swellex type) initially as additional support. As conditions are assessed, consideration should be given to moving towards a fully rock bolted system.

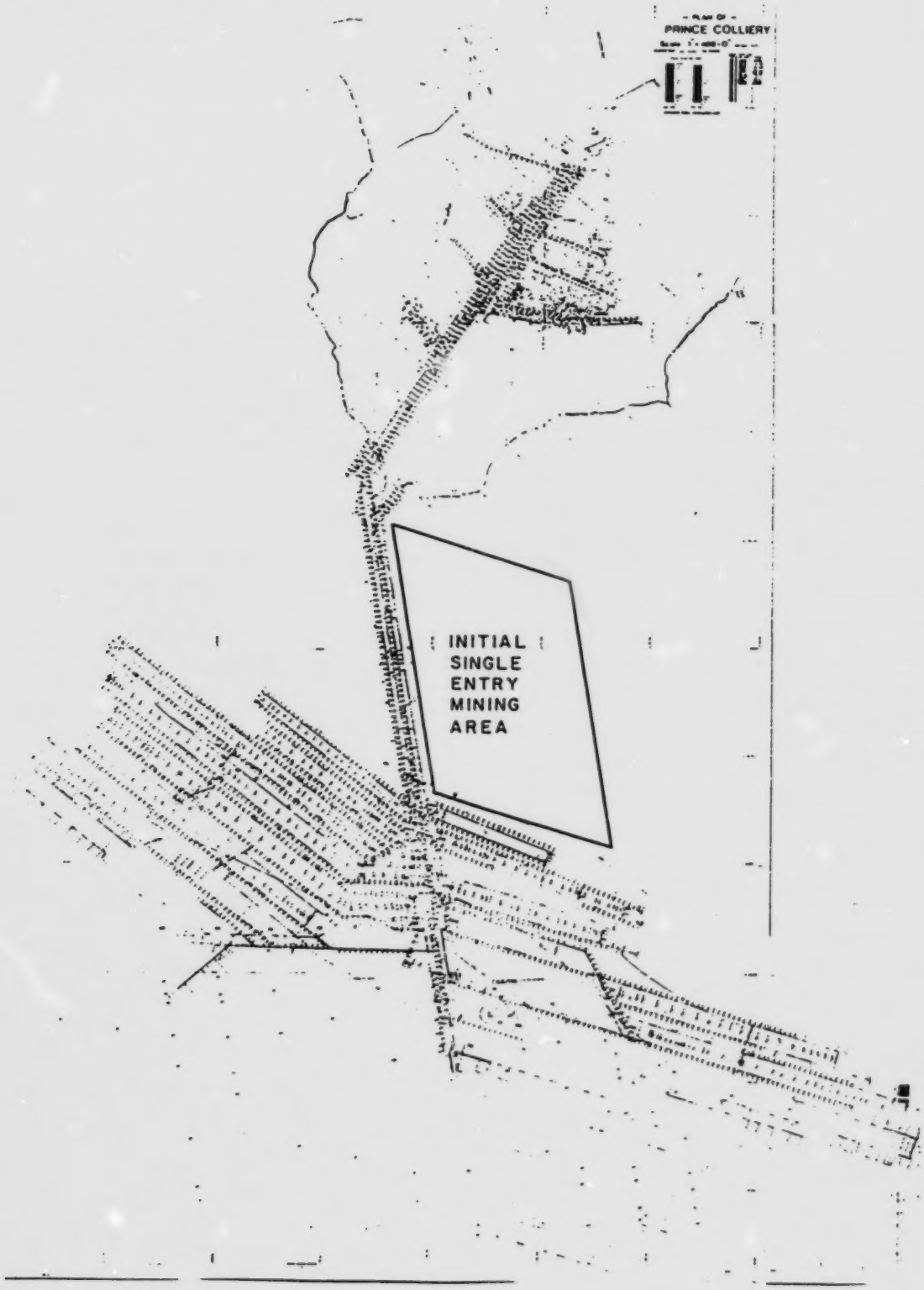
5. A training session for management and labour, including the setting up of the system on the surface during the commissioning process, should be a necessary part of the introduction of the SESLR system.

6. A detailed record of the initial operations of the SESLR system should be kept in order that the causes of any problems may be identified, remedial action taken and the system design modified. This should be subject to independent review.



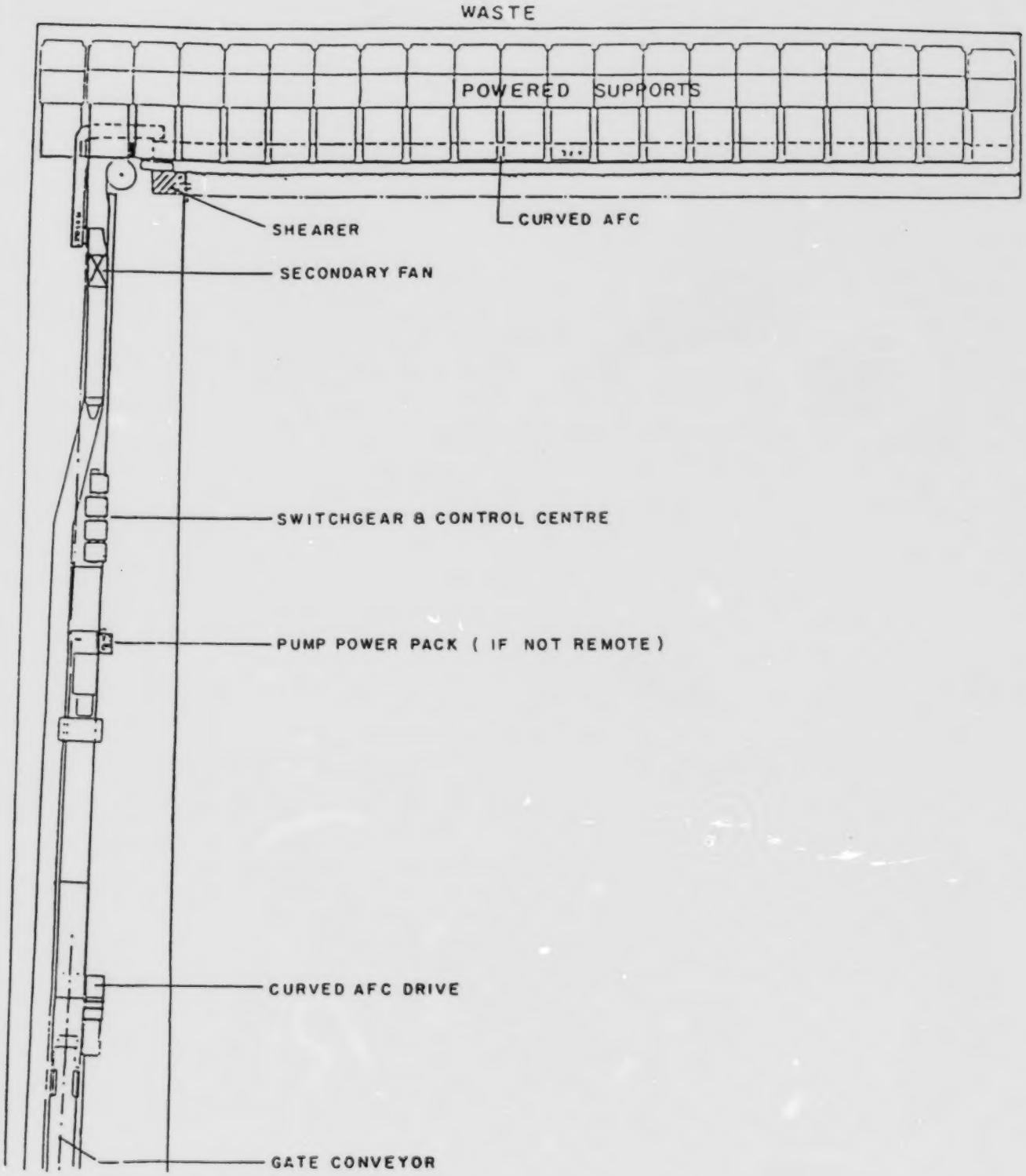
LOCATION OF CBDC MINES

FIGURE 1



SELECTED SINGLE ENTRY MINING AREA - PRINCE MINE

FIGURE 2



SINGLE ENTRY FACE - BASIC LAYOUT

FIGURE 3

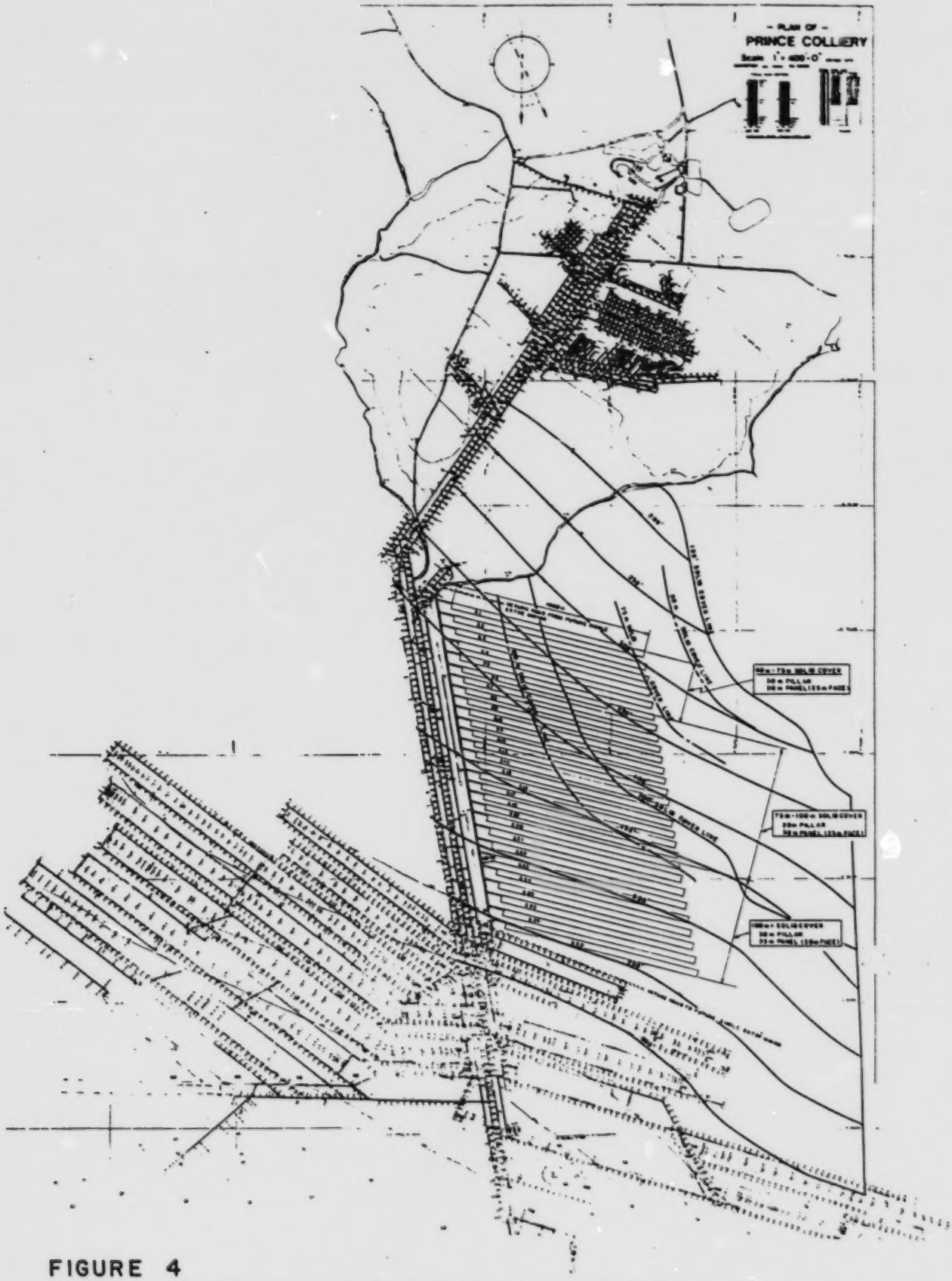
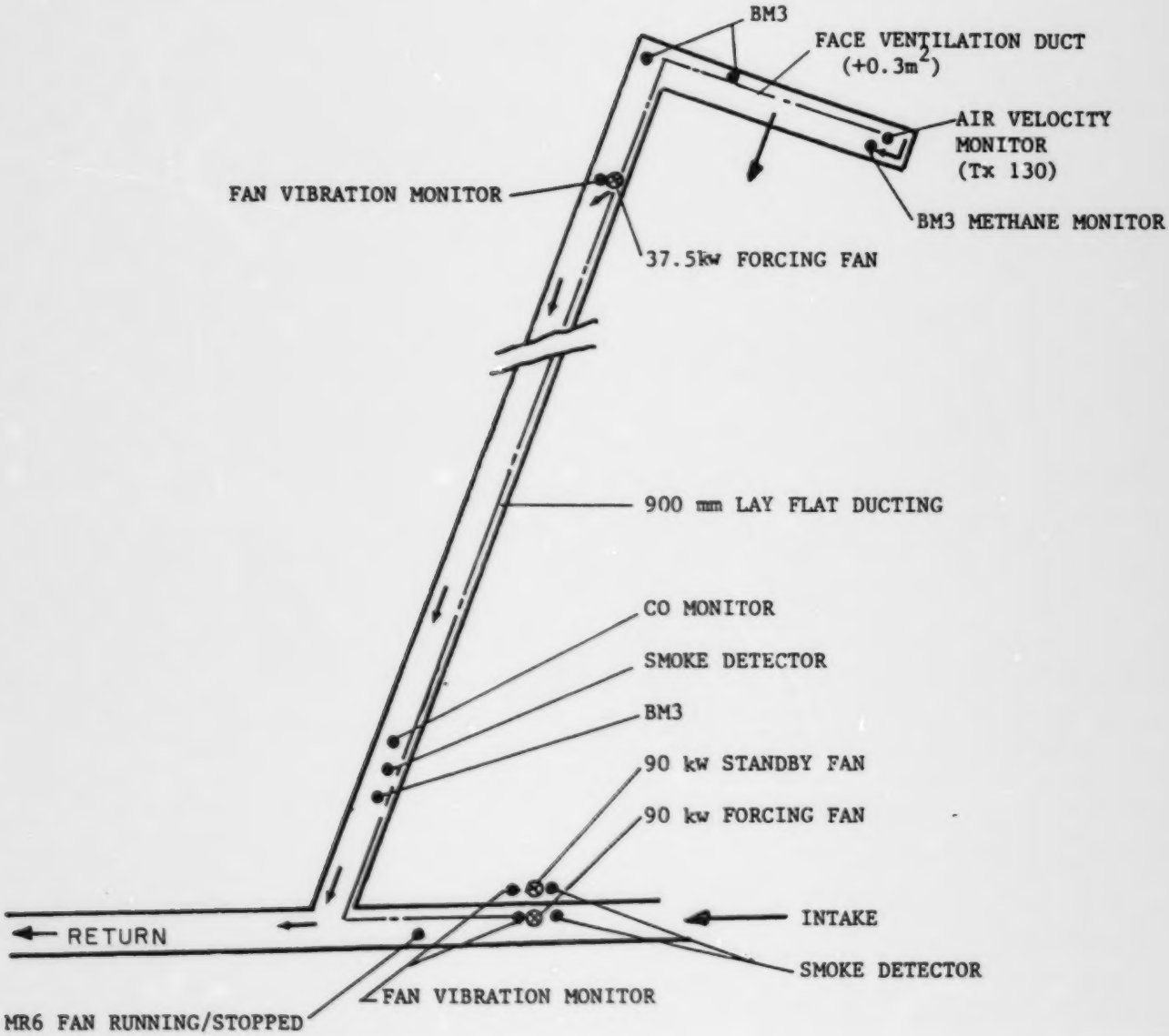


FIGURE 4
SINGLE ENTRY MINING-PROPOSED LAYOUT OF INITAL MINING AREA



VENTILATION & MONITORING SYSTEM
RETREATING FACE

FIGURE 5

TABLE 1 SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

MINE Country Face		WISTOW UK A14	SHERWOOD UK 133	HAMSFIELD UK 204	BEVERCOTES UK 99A	PYE HILL UK K49R	S. KIRKBY UK E08	MEASHAM UK 37	CADLEY HILL UK SE1	GRETLEY Australia N/1
NO. OF SINGLE ENTRY FACES WORKED		16	1	3	1	1	4	1	2	1
DATE SINGLE ENTRY FACE OPERATED		Aug/83 to date	May 87 to date	Jan 87 to date	1986	1983	1980	1982	1984	Start Jun 1988
GEOLOGY										
Depth of coal	(m)	310	600	665	-		415	130	-	75
Thickness of seam	(m)	2.4	3.4 (3.1 mined)	2.3	1.50	1.85	1.60	1.50	2.25	1.8 - 2.5
Dip of seam	(deg)	4	3	3	level	2	1.7	6.4	-	flat
Rock type - immediate roof		shale/siltstone	coaly shale	mudstone	-	-	-			-
- floor		mudstone	mudstone	siltstone	-	-	-			-
SINGLE ENTRY ROADWAYS										
Width	(m)	4.57	5.7	5.2	3.6	4.3	4.88	3.44	3.96	4.88
Height	(m)	2.44	3.1	2.9	2.8	2.4	1.98	2.44	2.13	2.2
Shape		rectangular	flat top arch	flat top arch	flat top arch	flat top arch	flat top arch	arch	flat top arch	rectangular
Area - ventilation	(m^2)	10	16.7	15	10	9	9.6	6.7	8.4	9.8
Maximum length	(m)	1000	1240	960	600	240	600	270	400	2000
Minimum length	(m)	700	-	450	-	-	-	-	-	-
Support - type		steel beam/legs	Hollybank 3 pc	Hollybank 3 pc	Hollybank 3 pc	Hollybank 3 pc	Hollybank 3-pc	3 pc arch	3 pc arch	rock bolt + strap
- spacing	(m)	0.9	1.0	1.2	1.0	1.07	0.91	0.9	0.91	1.5
Drivage method - M/C type		BJD Heliminer	Dosco Mk 2B	JCN 12	-	-	Dosco Dintheade	-	-	Jeffrey 1036
- power (cutting)			82	260	-	-	90	-	-	-
- coal removal		1.07m conveyor	1.2m conveyor	1.07 conveyor	-	-	conveyor	-	-	Shuttle car/CV
- ventilation					-	-		-	-	-
- fan	(kW)	90(F), 37.5(E)	2 x 37.5kW (F)	90 (F)	-	-	-	-	-	-
- ducting		lay flat	glass fibre	lay flat	-	-	-	-	-	-
- diameter	(m)	760	760	900	-	-	-	-	-	-
- volume	(m^3)	6.0	6.0 & 3.0	3.0 min	-	-	-	-	-	-
Performance - average week	(m)	150	90	55	-	-	-	-	-	-
- best week	(m)	170	100	82	-	-	-	-	-	-
- best shift	(m)	20	12	10.4	-	-	-	-	-	20
- manpower/shift		6	7	4	-	-	-	-	-	-

TABLE 1 SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

MINE		WISTOW	SHERWOOD	MANSFIELD	BEVERCOTES	PYE HILL	S. KIRKBY	MEASHAM	CADLEY HILL	GRETLEY
Country		UK	UK	UK	UK	UK	UK	UK	UK	Australia
Face		A14	133	204	99A	K498	E08	37	SE1	MW1
SINGLE ENTRY FACE										
Geometry.										
· face length	(m)	35	55	45	60	14	35	50	45	36
· panel length	(m)	1000	1240	960	600	240	600	270	400	2000
· mining height	(m)	2.1	3.1	2.3	1.5	1.53	1.60	1.50	1.98	2.0
· entry height	(m)	2.44	3.1	2.3	2.8	2.40	1.98	2.44	2.25	2.2
· entry width	(m)	4.57	5.4	5.2	3.6	4.30	4.88	3.44	3.96	4.88
· top coal left	(m)	0.34	0.3	-	-	0.32	no	no	0.27	no
· rib pillar size	(m)	55	50	55	-		35		25	25
· panel pillar size	(m)	30	60	60	-	-	40	-	40	32
· mining remnant/virgin		virgin	virgin	virgin	remnant	remnant	remnant	remnant	remnant	virgin
· panel extraction	(%)	39	52	45	-	-	47	-	64	59
Equipment.										
· Mining Machine										
· model		AS500 DERDS	BJD 859 DERDS	AM17 DERDS	AM17 DERDS	DOSCO ISM 1530	AM SERDS	AB16 SERDS	BJD 859 DERDS	BJD ACE SERDS
· power	(kW)	300	225	202	202	90	150	149	150	300
· max. cutting speed	(m/min)	10	10	10	10	-	-	-	-	10
· haulage system		Racketrack	Racketrack	Racketrack	Racketrack	-	racketrack	racketrack	roll track	BJD Multitrack
· drum dia.	(m)	1.68	1.68	1.65	1.52	-	1.37	1.15	1.37	1.5
· web depth	(m)	0.76	0.68	0.65	0.68	-	0.68	0.61	0.75	1.0
· pick speed	(m/s)					-	-	-	-	-
· special features		vent. drum PFF		RAC drum	FIDO arm	-	-	-	PFF	3 shoe w/frame
· AFC or Special c/v										
· headframe		Mining Supplies	MCB Spec.	Mining Supplies	MCB Spec	ISM flights	MCB Spec	MCB Spec	Heco Curved AFC	Halbach & Braun EKF2 Curved AFC
· gearbox		Winster 90 deg	Winster 90 deg	Mining Supplies	MCB Spec	-	MCB Spec	MCB Spec	in line	in line
· power	(kW)	112	120	150	112	-	48	67	112	160
· chain	(mm)	2 x 22 O/B	2 x 22 I/B	2 x 22 I/B	2 x 19 O/B	-	2 x 19 O/B	2 x 19 O/B	1 x 26 I/B	1 x 30 I/B
· furnishings		Pitcraft	Pitcraft	Pitcraft	Pitcraft	-	Pitcraft	Pitcraft	Pitcraft	std
· features		coal sizer 0.28 m^2 duct	0.29 m^2 duct	0.30 m^2 duct	0.27m^2 duct	-	0.26m^2 duct	no steel duct	0.2 m^2 duct	-
· Stage Loader										(as above)
· type		Beam	Beam	Beam	Beam	ISM conveyor	Beam	Beam	Curved AFC	60m length
· length	(m)	23	30	25	-	-	-	10m overlap	67.5 total	20m in gate
· drive		direct	direct	-	MCB Spec	-	-	MCB Spec	(22.5m in gate)	-
· power	(kW)	112	120	112	112	-	48	49	-	-
· chain		2 x 22 O/B	2 x 22 O/B	2 x 19 O/B	2 x 19 O/B	-	2 x 19 O/B	2 x 19 O/B	-	-
· furnishings			coal sizer	coal sizer	-	-	-	-	90 dg rollcurve	112 kW coal sizer
· Powered Supports (Face)										
· type		Dowty 4 x 450t	Gullick 4x370t	Dowty 4x325t	Gullick 6x240t	Dowty 6x240t	GD 5 leg 200t	Dowty 4 leg 203t	Dowty 4leg 280t	Dowty 2 leg 400t
· model		chock shields	chock shields	chock shields	chocks	chocks	shields	shields	chock shield	Sealed shields
· centres		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.0
· power pack		Gullick remote	Hawhinco remote	Gullick remote	Gullick local	-	remote	Gullick remote	Gullick remote	local
· control system		Dowvel	manual adjacent	Bi-di adjacent	-	-	-	-	Electrohydraulic	Electro-hydraulic
· auxilliary support		face sprags	face sprags	hydr. forepoles	-	-	-	-	-	-

TABLE 1 SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

MINE		WISTOW	SHERWOOD	MANSFIELD	BEVERCOTES	PYE HILL	S. KIRKBY	MEASHAM	CADLEY HILL	GRETLEY
Country		UK	UK	UK	UK	UK	UK	UK	UK	Australia
Face		A14	133	204	99A	K49R	E08	37	SE1	MW1
SINGLE ENTRY FACE										
			blind end plate							
· Powered Supports (Roadhead)										
· type		Dowty 4 x 280t	Dowty 4 x 280t	Dowty 4 x 325t	Gullick 5 x 325t	Dowty chocks	Gullick	Dowty 4 x 203t	Dowty 4 x 280t	Dowty 2 leg 400t
· model		chock shields	chock shields	chock shields	chocks	Desford 4 I/L	1-8 leg anchor	4 in line	chock shields (2)	shields
· number		3	2	3	2	2Dowty+1Desford	2-9 leg chocks	1	1 + 2leg 60t ext	2
· features		ext. canopies	ext. cantilever	ext. cantilever	_	sliding chocks	w/ SMRE canopy	at roadside	1 + 2leg 30t ext	_
Ventilation.										
· primary fan	(kW)	90(F)	90 (F)	90 (F)	90 (F)	37 (F)	90 (F)	37 (E)	37 (E)	none
· secondary fan	(kW)	90(F)	2 X 37.5 (F)	37.5 (F)	37.5 (F)	4(F)	11 (F)	19 (F)	37 (F)	none
· ventilation primary	(m^3/s)	6.5	6.0 (5.0 min)	6.0 (5.0 min)	7.0	5.0	6.5	3.0 min	6.5	air returns
· ventilation secondary	(m^3/s)	2.5	3.5	4.0	4.5	3.0	2.0	2.0 min	2.0	through goaf
· ventilation face	(m^3/s)	4.5 min.	3.0 min	3.0 min	3.5 min	3.0	2.0	2.0 min	2.0	_
· methane emission	(m^3/s)	0.40	0.04	0.011	0.020	_	low	low	low	low
· safety features										
· methane monitor		BM1	BM3	BM1 & BM3	BM3	BM1	BM1	BM1	BM1	not known
· air flow monitor		TX130	BA5	BA5	BA5	TX130	BA4	TX140	TX130	not known
· CO detector		yes	yes	yes	yes	yes	yes	yes	yes	not known
· smoke detector		yes	yes	yes	yes	yes	yes	yes	yes	not known
· fan vibration		yes	yes	yes	yes	yes	yes	yes	yes	_
Manpower (Shift).										
· face machine		2	2	2	_	2	2	1	2	2
· supports		1	2	1	_	1	2	3	3	1
· stage loader/consol		1	1	1	_	1	1	1	1	1
· supervision		1	1	1	_	1	1	1	1	1
· maintenance (E)		0.5	0.5	0.5	_	1	0.5	1	1	1
· maintenance (M)		0.5	0.5	0.5	_	1	0.5	1	1	1
· supplies		0.6	1	-	_	_	_	_	_	_
· other		-	-	-	_	_	_	_	_	_
Performance.										
								(1 shift)		
· average advance/week	(m)	150	-	62.6	_	34 (5 shifts)	23.2	_	30	40 - 60 (est)
· best advance/week	(m)	180	90	92.2	_	_	_	_	_	_
· avge tonnes/week	(t)	22500	-	5461	_	984	1380	730	6000	_
· best tonnes/week	(t)	26928	8000	8039	_	1445	1777	1100	_	_
· avge tonnes/shift	(t)	1500	-	429	_	197	_	_	1200	_
· OMS (t) average	(t/MS)	240	120	84.5	_	24.6	16.3	16.4	57.1	_

TABLE 1 SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

MINE		WISTOW	SHERWOOD	MANSFIELD	BEVERCOTES	PYE HILL	S. KIRKBY	MEASHAM	CADLEY HILL	GRETLEY
Country		UK	UK	UK	UK	UK	UK	UK	UK	Australia
Face		A14	133	204	99A	K49N	E08	37	SE1	NW1
COAL CLEARANCE										
- Gate Conveyor - type		FSW Modular	FSW Modular	FSW Modular	-	FSW Lion	Nuwood	-	-	Fox in Seam
- width	(m)	1.07	1.2	1.07	-	0.91	0.91	-	-	1.05
- speed	(m/s)	2.5	2.4	2.1	-	-	-	-	-	-
- capacity	(tph)	1000	1100	1080	-	-	-	-	-	800
- length	(m)	1050	1240	900	-	-	-	-	-	2070
- rise/(fall)	(m)			-	-	-	-	-	-	0
- power	(kW)	112	112	112	-	-	-	-	-	225
- LTU storage	(m)	100	96	50	-	-	-	-	-	168
MATERIALS SUPPLY										
- Equipment used		diesel loco battery loco flat bed cars	diesel loco flat bed cars	GD NP100 FSV	-	-	-	-	-	FSV
FACE INSTALLATION/RECOVERY/TRANSFER										
- Elapsed time - installation		1 week	2 weeks	42 shifts	-	-	-	-	-	-
- recovery/transfer		1 week	est. 2 weeks	42 shifts	-	-	-	-	-	Estimated 3 days
- Equipment used - face supports		Eimco 913 FSV	Eimco 913 FSV	FSV	-	-	-	-	-	FSV
- other		locomotive	locomotive	FSV	-	-	-	-	-	FSV
REGULATORY LIMITATIONS										
- Special conditions		specific monitoring	specific monitoring	specific monitoring	specific monitoring	specific monitoring	specific monitoring	specific monitoring	specific monitoring	not known
- Exemptions		12 man limit	9 man limit	9 man limit 18 man exemptio	9 man limit 18 man exemption	12 man limit	9 man limit	not known	not known	not known
FACE/DISTRICT PERFORMANCE										
- Revenue ($/t)	($/t)			104.20	-	-	80.77	-	-	-
- Operating Cost ($/t)	($/t)							-	-	-
- Labour	($/t)		-	3.10	-	73.6	18.80	-	-	-
- Materials	($/t)		-	0.67	-	18.6	10.50	-	-	-
- Power	($/t)		-	0.35	-	-	1.80	-	-	-
- Other	($/t)		-	5.73	-	-	5.60	-	-	-
- Total	($/t)		-	9.85	-	92.0	36.7	-	-	-

TABLE 1 SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

MINE		STOLZENBACH	RHEINLAND	OCP #14	NORGRAD	WHITWICK	ALLERTON BYWATER	WATH	ROYSTON DRIFT	LEDSTON LUCK
Country		W. Germany	W.Germany	Morocco	Hungary	UK	UK	UK	UK	UK
Face		#21	HG1	-	-	-	-	-	-	-
SINGLE ENTRY FACE										
Geometry.										
- face length	(m)	50	33	26	50	-	50	7	40	40
- panel length	(m)	500	600	-	-	-	-	-	-	-
- mining height	(m)	3.3	1.95	2.85	2.85	-	-	-	-	-
- entry height	(m)	3.3	4.0	-	2.85	-	-	-	-	-
- entry width	(m)	3.4	5.8	-	3.50	-	-	-	-	-
- top coal left	(m)	no	no	-	no	-	-	-	-	-
- rib pillar size	(m)	not known	-	-	-	-	-	-	-	-
- panel pillar size	(m)	not known	-	-	-	-	-	-	-	-
- mining remnant/virgin		virgin	remnant	virgin	virgin	-	-	-	-	-
- panel extraction	(%)	not known	-		-	-	-	-	-	-
Equipment.										
- Mining Machine										
- model		Eickhoff ESA60L	Eickhoff ESA150	Westfalia VHE	Westfalia VHE	Dosco ISM	AM500 DERDS	AM SERDS	AM DERDS	-
- power	(kW)	60	150	120	120	-	-	-	-	-
- max. cutting speed	(m/min)	9	-	20	20	-	-	-	-	-
- haulage system		Eicotrack	Eicotrack	chain	chain	-	-	-	-	-
- drum dia.	(m)	1.60	1.05	0.9	0.9	-	-	-	-	-
- web depth	(m)	0.625	0.75	-	-	-	-	-	-	-
- pick speed	(m/s)	-	-	3.1	3.1	-	-	-	-	-
- special features		PFF	PFF	-	-	-	-	-	-	-
- AFC or Special c/v		Halbach & Braun	Eickhoff EKF2							
- headframe		curved AFC	std	Westfalia PF230	Westfalia PF230	-	-	-	-	-
- gearbox		EKF2	std	-	-	-	-	-	-	-
- power	(kW)	200		-	-	-	-	-	-	-
- chain	(mm)	1 x 30 I/B	1 x 26 I/B	-	-	-	-	-	-	-
- furnishings		Standard	std	-	-	-	-	-	-	-
- features		Roller curve	spillage c/v	-	-	-	-	-	-	-
- Stage Loader			none							
- type		(as above)	AFC	-	-	-	-	-	-	-
- length	(m)	82m total	loads	-	-	-	-	-	-	-
- drive		in line	direct	-	-	-	-	-	-	-
- power	(kW)	-	onto	-	-	-	-	-	-	-
- chain		-	belt	-	-	-	-	-	-	-
- furnishings		-	conveyor	-	-	-	-	-	-	-
- Powered Supports (Face)						-	-	-	-	-
- type		Hemscheidt 2 leg	Kloechner	-	-	-	-	-	-	-
- model		490t shields	2 leg shields	-	-	-	-	-	-	-
- centres		1.5	1.5	-	-	-	-	-	-	-
- power pack		Hauhinco remote	remote	-	-	-	-	-	-	-
- control system		pilot	-	-	-	-	-	-	-	-
- auxiliary support		blind end sides	props & bars	-	-	-	-	-	-	-

TABLE 1 SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

MINE		STOLZENBACH	RHEINLAND	OCP #14	MORGRAD	WHITWICK	ALLERTON BYWATER	WATH	ROYSTON DRIFT	LEDSTON LUCK
Country		W. Germany	W.Germany	Morocco	Hungary	UK	UK	UK	UK	UK
Face		#21	HG1	-	-	-	-	-	-	-
SINGLE ENTRY FACE										
			at roadside							
· Powered Supports (Roadhead)										
· type		Hemscheidt 2leg	none	-	-	-	-	-	-	-
· model		G490 SHIELDS	props & link	-	-	-	-	-	-	-
· number		2	bars - 4 rows	-	-	-	-	-	-	-
· features		1.5M ext canopy	-	-	-	-	-	-	-	-
Ventilation.										
· primary fan	(kW)	not known	24 + comp. air	-	-	-	-	-	-	-
· secondary fan	(kW)	not known	-	-	-	-	-	-	-	-
· ventilation primary	(m^3/s)	not known	10	-	-	-	-	-	-	-
· ventilation secondary	(m^3/s)	not known	-	-	-	-	-	-	-	-
· ventilation face	(m^3/s)	flexiduct	10	-	-	-	-	-	-	-
· methane emission	(m^3/s)	non-gassy	non gassy	-	-	-	-	-	-	-
· safety features		not known	-	-	-	-	-	-	-	-
· methane monitor		not known	yes	-	-	-	-	-	-	-
· air flow monitor		not known	yes	-	-	-	-	-	-	-
· CO detector		not known	yes	-	-	-	-	-	-	-
· smoke detector		not known	not known	-	-	-	-	-	-	-
· fan vibration		not known	not known	-	-	-	-	-	-	-
Manpower (Shift).										
· face machine		1	2	-	-	-	-	-	-	-
· supports		2	2	-	-	-	-	-	-	-
· stage loader/consol		2	1	-	-	-	-	-	-	-
· supervision		1	1	-	-	-	-	-	-	-
· maintenance (E)		1	1	-	-	-	-	-	-	-
· maintenance (M)		1	1	-	-	-	-	-	-	-
· supplies		-	-	-	-	-	-	-	-	-
· other		-	4	-	-	-	-	-	-	-
Performance.										
· average advance/week	(m)	45.0	75 (E)	160	-	-	-	-	-	-
· best advance/week	(m)	51.5	-	-	-	-	-	-	-	-
· avge tonnes/week	(t)	7800	10500 (E)	14255	-	-	-	-	-	-
· best tonnes/week	(t)	8900	-	-	-	-	-	-	-	-
· avge tonnes/shift	(t)	920	700 (E)	-	-	-	-	-	-	-
· OMS (t) average	(t/MS)	88	58 (E)	69	-	-	-	-	-	-

TABLE 1 SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

MINE Country Face		STOLZENBACH W. Germany #21	RHEINLAND W.Germany NG1	OCP #14 Morocco -	MORGRAD Hungary -	WHITWICK UK -	ALLERTON BYWATER UK -	WATH UK -	ROYSTON DRIFT UK -	LEDSTON LUCK UK -
COAL CLEARANCE										
· Gate Conveyor · type		-	-	-	-	-	-	-	-	-
· width	(m)	0.8	-	-	-	-	-	-	-	-
· speed	(m/s)	2.5	-	-	-	-	-	-	-	-
· capacity	(tph)	-	-	-	-	-	-	-	-	-
· length	(m)	-	-	-	-	-	-	-	-	-
· rise/(fall)	(m)	-	-	-	-	-	-	-	-	-
· power	(kW)	-	-	-	-	-	-	-	-	-
· LTU storage	(m)	-	-	-	-	-	-	-	-	-
MATERIALS SUPPLY										
· Equipment used		-	-	-	-	-	-	-	-	-
FACE INSTALLATION/RECOVERY/TRANSFER										
· Elapsed time · installation		12 - 14 days	-	-	-	-	-	-	-	-
· recovery/transfer		incl rec/transfe	-	-	-	-	-	-	-	-
· Equipment used · face supports		diesel monorail	-	-	-	-	-	-	-	-
· other		diesel monorail	-	-	-	-	-	-	-	-
REGULATORY LIMITATIONS										
· Special conditions		not known	Very stringent on methane	-	-	-	-	-	-	-
· Exemptions		not known	none	-	-	-	-	-	-	-
FACE/DISTRICT PERFORMANCE										
· Revenue ($/t)	($/t)	-	-	-	-	-	-	-	-	-
· Operating Cost ($/t)	($/t)	-	-	-	-	-	-	-	-	-
· Labour	($/t)	-	-	-	-	-	-	-	-	-
· Materials	($/t)	-	-	-	-	-	-	-	-	-
· Power	($/t)	-	-	-	-	-	-	-	-	-
· Other	($/t)	-	-	-	-	-	-	-	-	-
· Total	($/t)	-	-	-	-	-	-	-	-	-

TABLE 1 SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

MINE Country Face		STOLZENBACH W. Germany #21	RHEINLAND W.Germany HG1	OCP #14 Morocco	MORGRAD Hungary	WHITWICK UK	ALLERTON BYWATER UK	WATH UK	ROYSTON DRIFT UK	LEDSTON LUCK UK
NO. OF SINGLE ENTRY FACES WORKED		22	(2)	1	(1)	several	1+	1	1	1
DATE SINGLE ENTRY FACE OPERATED		1982 to present	Proposed	1985	June 1988	1980 - 85	current	1980	1983	1983
GEOLOGY										
Depth of coal	(m)	160	730	-	-	-	-	-	-	-
Thickness of seam	(m)	3.5 - 5.0	1.95	2.85	2.85	-	-	-	-	-
Dip of seam	(deg)	-	3	-	-	-	-	-	-	-
Rock type - immediate roof		Hard clay	-		-	-	-	-	-	-
- floor		-	-		-	-	-	-	-	-
SINGLE ENTRY ROADWAYS										
Width	(m)	3.4	5.8	-	3.50	-	-	-	-	-
Height	(m)	3.3	4.0	-	2.85	-	-	-	-	-
Shape		Trapezoidal	Arch	-	rectangular	-	-	-	-	-
Area - ventilation	(m^2)	10	18	-	10.0	-	-	-	-	-
Maximum length	(m)	500	600	-	-	-	-	-	-	-
Minimum length	(m)	260	-	-	-	-	-	-	-	-
Support - type		3 pc steel	4 pc steel	-	-	-	-	-	-	-
- spacing	(m)	-	-	-	-	-	-	-	-	-
Drivage method - M/C type		-	-	-	-	-	-	-	-	-
- power (cutting)		-	-	-	-	-	-	-	-	-
- coal removal		-	-	-	-	-	-	-	-	-
- ventilation		-	-	-	-	-	-	-	-	-
- fan	(kW)	-	-	-	-	-	-	-	-	-
- ducting		-	-	-	-	-	-	-	-	-
- diameter	(m)	-	-	-	-	-	-	-	-	-
- volume	(m^3)	-	-	-	-	-	-	-	-	-
Performance - average week	(m)	-	-	-	-	-	-	-	-	-
- best week	(m)	-	-	-	-	-	-	-	-	-
- best shift	(m)	-	-	-	-	-	-	-	-	-
- manpower/shift		-	-	-	-	-	-	-	-	-

TABLE 2

COMPARISON OF SINGLE ENTRY SHORT LONGWALL FACES

	SHEARER	ESA/VME
Face Length	Same	Same
Face Height	5.0 m max.	3.5 m max.
Power	150-375 kW	60-183 kW
AFC Pan/chain	Standard	Standard
AFC Furnishings (incl. vent. duct)	Standard	Standard(ESA) Special(VME)
Chainless Haulage	Standard	Standard(ESA) Chain (VME)
Powered Supports	Standard	Standard
Stage Loader	Standard	Standard
Curved Conveyor (Alternative)	Standard	Standard
Roadhead Supports	Standard	Standard
Ventilation System	Same	Same
Monitoring System	Same	Same
Production Capacity (Best)	26,928 t	14,255 t
Capital Cost	Higher	Lower
Operating Cost	Same	Same

TABLE 3(a)

SUMMARY SPECIFICATION FOR SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

PRINCE MINE
ROADWAY DRIVAGE & FACE LINE DEVELOPMENT

Depth of Cover	60 m
Seam Height	2.3 m
Face Length	25 m - 30 m
Pillar Width	20 m - 30 m
Panel Length	1000 m
Gradient	0.5° - 1.5°
Roadway Width	5 m
Face Line Width	6 m
Drivage Machine	- Westfalia VME Roadheader - 5.0 m wide - 120 kW cutting power - curved gathering and discharge conveyor - 0.9 in. diameter cutting drum with pick face flushing
Coal Clearance	- FSW In-Seam modular conveyor - 1.07 m wide belt - 112 kW drive - automatic loop take up and belt reel station - 100 m belt storage capacity - 990 tph capacity
Roadway Supports	- 3 powered anchor chocks behind VME supporting heading face, carrying girder setting device at rear - 150 mm x 150 mm RSJ roof beams 5 m long, supported on two 150 mm x 150 mm steel legs bolt/clamped to roof beam, set at 1.0 m intervals

TABLE 3(a) (Cont'd)

SUMMARY SPECIFICATION FOR SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

PRINCE MINE
ROADWAY DRIVAGE & FACE LINE DEVELOPMENT

	- 4 - 1.8 m long swellex rock bolts set between steel sets using stoper drilling equipment - roof and sides meshed - foot blocks used under steel legs
Materials Transport	- Eimco 913 FSV with attachments

Ventilation	- 90 kW 914 mm primary forcing fan located in intake roadway
	- 914 mm lay flat ducting
	- primary flow 8 m^3/s
	- 37.5 kW 760 mm exhausting fan located 10 m outbye end of 760 mm primary ducting, using spiral reinforced ducting
	- exhausting from heading face at 4.5 m^3/s
	- microdyne dust extractor in exhausting fan circuit
	- on primary fan circuit
	  - Air velocity (TX130) at duct exit
	  - BM3 methane monitor outbye secondary system
	  - CO and smoke detector at outbye end of single entry
	  - smoke detector at intake to primary fan
	  - fan vibration monitor on primary fan
	  - power on/running status on primary fan

TABLE 3(a) (Cont'd)

SUMMARY SPECIFICATION FOR SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

PRINCE MINE
ROADWAY DRIVAGE & FACE LINE DEVELOPMENT

	- on secondary fan circuit - fan vibration monitor on secondary fan - power on/running status on secondary fan - when driving face line, add BM3 at face heading and TX 130 in secondary fan outlet	
Manpower	Heading machines	4
	Rock Bolting	2
	Electrician	.5
	Mechanic	.5
	Materials Supply	1
	Gate Belt Conveyor	1
	Supervision	1
		10
Peformance	15 m/shift	

TABLE 3(b)

SUMMARY SPECIFICATION FOR SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

PRINCE MINE
RETREATING FACE

Depth of Cover	60 m
Seam Height	2.3 m
Face Length	25 m - 30 m
Pillar Width	20 m - 30 m
Panel Length	1000 m
Gradient	0.5° - 1.5°
Roadway Width	5 m
Shearer	- BJD ACE (or AM500) DERDS - 375 (300) kW motor - 1.7 m dia. cutting drum equipped with back face flushing and RAC dust control - 1.05 m web - chainless haulage - short length machines - Pitcraft onboard water boost pump - maximum cutting speed 12 m/min
AFC/Stage Loader	- Halback & Braun (or Dowty Meco) curved chain conveyor - 200 kW two speed direct start motor - 990 tph capacity - total length 60 m - single inboard 30 mm chain 0.5 m flight spacing - 270 mm x 764 mm pan - speed 1.0 m/min - fixed discharge to gate conveyor - special spill plates incorporating 0.3 m^2 ventilation ducting

TABLE 3(b) (Cont'd)

SUMMARY SPECIFICATION FOR SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

PRINCE MINE
RETREATING FACE

	- Perard cable handler/trough - non-driven return end - underplated line pans
Face Supports	- Hemscheidt 2 leg 320 t shields with powered forward cantilever at 1.5 m spacing - remote power pack using 60 mm pressure line and 75 mm return line
Roadhead Supports	- 3 - Hemscheidt 2 leg 320 t shields with extended rigid canopies, or - 3-4 leg anchor chocks with extended beams and 5th leg at end of beam
Gate Conveyor	- as per development specification
Materials Handling	- as per development specification
Ventilation	- 90 kW primary forcing fan, 914 mm dia, located in intake roadway - 914 mm dia lay flat ducting - primary flow 8.0 m^3/s - 37.5 kW secondary forcing fan, 760 mm dia. in series with primary fan and located on gate section of curved AFC - secondary flow 5.0 m^3/s (4.5 m^3/s minimum) through face ventilation duct

TABLE 3(b) (Cont'd)

SUMMARY SPECIFICATION FOR SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

PRINCE MINE
RETREATING FACE

Monitoring	- BM3 methane monitors at blind end of face, mid face and roadway/face area - TX130 air velocity monitor in discharge end of face duct - fan vibration and power status/fan running monitors on secondary fan - CO & smoke detection at outbye end of single entry roadway - smoke detection at inlet to primary fan - fan vibrator and power status/fan running monitors on primary fan
Manpower	Shearer 2 Supports 1 Roadhead/Consol 1 Electrician .5 Mechanic .5 Materials 1 Gate Conveyor 1 Supervision 1 8
Performance	- 15 strips/shift - 1130 t/shift - 17950 ROM t/week - face OMS 169 t/MS

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2 Comparaison de fronts de moyennes tailles borgnes

3 Sommaire des devis d'exploitation rabattante de moyennes tailles borgnes

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1.0 INTRODUCTION

Le présent rapport a été établi pour le compte du laboratoire de la recherche houillère Cape Breton de la CANMET à Sydney (N.-É.). Il a pour but d'évaluer la faisabilité et la rentabilité de l'exploitation rabattante par moyenne taille borgne dans certaines conditions qui caractérisent le gisement carbonifère de Sydney en Nouvelle-Écosse, Canada.

2.0 MÉTHODE D'ÉTUDE

Nous avons consulté la SDCB et le service d'inspection des mines, et visité les mines en activité de la SDCB, pour nous renseigner au sujet des conditions et méthodes d'exploitation qui dominent dans le gisement carbonifère de Sydney.

Nous avons ensuite rassemblé des données sur l'exploitation rabattante par moyenne taille borgne (ERMTB) au moyen des démarches suivantes :

- recherche documentaire dans huit bases de données internationales sur les mines, et dans la section minière internationale de la bibliothèque de l'ICIST;
- visite de mines en Grande-Bretagne, en Belgique et en Allemagne fédérale, et discussions avec les services d'inspection des mines de ces pays;
- rencontres avec des fabricant de matériel utilisé pour l'ERMTB;
- enquête postale auprès de mines qui utilisent ou ont utilisé la taille borgne, et de centres de recherche houillère en Grande-Bretagne, aux États-Unis, en RFA et en Australie.

Nous avons évalué les conditions qu'on trouve dans les mines Prince, Lingan et Phalen de la SDCB, puis isolé des secteurs qui se prêteraient à l'ERMTB. Nous avons aussi cerné les modalités d'application de l'ERMTB et ses éléments critiques à la lumière des données recueillies auprès des mines et autres sources compétentes. Enfin, nous avons sélectionné un secteur pour l'exploitation initiale et élaboré des lignes de conduite.

3.0 LES MINES DE LA SOCIÉTÉ DE DÉVELOPPEMENT DU CAP BRETON ET LES EMPLACEMENTS POSSIBLES

Nous avons décrit les trois mines de charbon sous-marines que la SDCB exploite au Cap Breton (Figure 1) et détaillé les chantiers de longue taille en exploitation ainsi que les travaux de développement.

La mine la plus ancienne est la mine Lingan, dont l'exploitation a débuté en 1972. On l'exploite par longue taille chassante selon un système conçu pour extraire 1,45 Mt par an de charbon épuré de la couche Harbour, puissante de 2,0 m, au moyen de trois longues tailles de 222 m. Les tailles actuelles se situent à 4 km des côtes, à 8° de pendage. La mine est très gazéifère; le taux d'émission de grisou atteint jusqu'à 30 m^3/t dans les longues tailles. La mine possède toutefois un système d'élimination très efficace.

La mine la plus récente de la SDCB, la mine Phalen, est située juste à côté de la mine Lingan; elle exploite la couche Phalen (1,8 à 2,45 m) à environ 180 m sous les galeries de la mine Lingan. La mine a commencé à exploiter en 1987 deux longues tailles rabattantes (qui ont actuellement 150 m de long) destinées à produire 1,6 Mt/an. La couche présente un pendage de 12° et un taux d'émission de grisou de 15 m^3/t. On s'attend à ce que les émissions augmentent à mesure que l'on continuera à s'enfoncer.

La troisième mine en exploitation, la mine Prince, est située à 25 km au N.-O. des mines Lingan et Phalen, sous la péninsule de la Pointe Aconi. La taille a débuté en 1976, selon la méthode des chambres et piliers. On a abandonné cette méthode à cause de la grande faiblesse du mur et on a ouvert un nouveau chantier à 4 km de la tête du tunnel comme mine de longue taille constituée de chantiers rabattants courts (113 m). La mine exploite la couche Hub (1,8 à 2,45 m) qui donne un rendement de 35 000 tonnes tout-venant par semaine pour une seule longue taille. La couche a un pendage de 2 à 3° et de faibles émissions de grisou (o,26 m^3/t).

Nous avons relevé des secteurs intacts qui conviennent à l'ERMTB dans chacune des trois mines. La zone la plus étendue et la mieux adaptée de par la faiblesse des émissions de grisou, le pendage et les caractéristiques générales, se situe dans la mine Prince, entre les longues tailles existantes et la côte (Figure 2).

4.0 L'EXPLOITATION RABATTANTE PAR MOYENNE TAILLE BORGNE

L'exploitation rabattante par moyenne taille borgne est un chantier de longue taille de faible étendue que dessert une seule galerie (alors qu'Américains et Australiens emploient l'équivalent anglais - "single entry short longwall retreating system" - pour désigner un chantier de longue taille qui possède une galerie à chaque extrémité).

L'exploitation rabattante par moyenne taille borgne sert depuis 1980, sous une forme ou sous une autre, à exploiter des massifs de houille isolés ou en piliers, à procéder par dépilage partiel là où il faut éliminer ou limiter les risques d'affaissement, ou comme méthode d'exploitation principale.

Quelques 17 mines situées en Grande-Bretagne, en RFA, en Australie et au Maroc ont employé le système à un moment ou un autre. Actuellement, il est utilisé par quatre mines britanniques, une mine allemande, une mine marocaine et une mine australienne. Par ailleurs, on sait que cinq nouvelles mines (trois en G.-B., une en RFA et une en Hongrie) envisagent de l'appliquer.

La mine Wistow, en Grande-Bretagne, a déjà exploité plus de 15 tailles selon cette méthode. La mine Stolzenbach, en Allemagne de l'Ouest, en est à sa 22e taille. Les mines Sherwood et Mansfield, en Grande-Bretagne, prévoient exploiter de nombreuses tailles car elles font traditionnellement du dépilage partiel sous les agglomérations urbaines.

Le Tableau 1 décrit les principales installations des 17 mines.

Le système d'ERMTB possède une structure de base et plusieurs versions possibles ou variantes d'équipement :

- o système de base - ventilation auxiliaire seulement;
- o version n° 1 - galerie traversante unique avec ventilation auxiliaire de la taille;
- o version n° 2 - galerie traversante unique avec retour de l'air derrière le soutènement et par l'arrière-taille;
- o variante 1 - emploi d'une même machine pour le traçage et l'exploitation.

Des 17 mines qui ont employé l'ERMTB, deux seulement n'ont pas utilisé le système de base. La version n° 1 a été proposée pour la mine Rheinland (RFA). La version n°2 a été conçue pour la mine Gretley (Australie), qui entre en exploitation en juin 1988. La variante n°1 n'a pas encore été appliquée à notre connaissance.

Le système de base est constitué d'une galerie unique (galerie de base), tracée sur une distance pré-établie à partir d'une galerie principale ou secondaire, d'où l'on exploite une longue taille de faible étendue (moyenne taille). La Figure 3 illustre la configuration typique. La longueur de la galerie de base dépend des conditions d'aérage et des dimensions du secteur à exploiter. On rabat ensuite la taille borgne vers la galerie principale ou secondaire, l'aérage de la galerie de base et de la taille étant assurée par des systèmes de ventilation auxiliaires. On creuse la galerie de base au moyen d'un mineur continu, d'une machine de traçage ou de matériel similaire, qui sert également à creuser la ligne de taille. On équipe ensuite la taille d'un soutènement marchant, d'une haveuse, d'un convoyeur à chaîne avec conduits de ventilations intégrés et de systèmes de surveillance et de communication. On installe un convoyeur répartiteur et un convoyeur à bande dans la galerie de base, ainsi que d'un soutènement hydraulique spécial à l'entrée de la taille. Le convoyeur répartiteur est doté d'un poste de contrôle regroupant les appareils de surveillance et de communication. Dans plusieurs installations récentes, on a remplacé le blindé de la taille et le convoyeur répartiteur par un unique convoyeur à chaîne curviligne. L'aérage se fait habituellement par ventilation forcée, des ventilateurs étant installés près de la taille et à la jonction de la voie de base. Le transport des matériaux se fait sur rail, à l'aide de berlines tirées par locomotive ou par treuil, ou sur pneumatiques, au moyen de tracteurs. La plupart des systèmes sont presque identiques, avec une taille de 30 à 50 m de long et une chambre d'un maximum de 1000 m, mais la sécurité et l'efficacité du chantier dépendent du temps consacré à la planification et du soin apporté aux détails de conception, de mise en oeuvre et d'exploitation.

Dans la version n° 1, la taille courte reste perpendiculaire à la galerie de base; on l'aère à l'aide de systèmes auxiliaires. Toutefois, la galerie d'accès n'est plus un cul-de-sac, car on l'entretien sur toute sa longueur. Elle est reliée à une voie d'entrée d'air et à une voie de retour d'air, de manière à assurer une circulation naturelle. On installe un dispositif de pompage en retrait de la voie, juste derrière le soutènement hydraulique, afin de maintenir la voie d'accès en bon état.

Dans la version n° 2, la courte taille borgne reste à angle droit avec la galerie traversante de base, ou avec la galerie de tête ou de pied d'un circuit d'aérage principal. Il n'y a aucun système de ventilation auxiliaire, car on installe un soutènement marchant étanche au dessus de la taille et à la jonction avec la galerie pour prévenir les infiltrations. L'air remonte donc la voie d'accès, dévie sur le front de taille, passe par le dernier soutènement du cul-de-sac et ressort de la mine. Cette solution de rechange repose sur le maintien d'une circulation par l'arrière-taille.

La variante n° 1 repose sur les mêmes principes que le système de base, mais fait appel à une seule machine pour creuser la galerie, tracer le chantier et abattre le minerai en taille rabattante. Il s'agit de machines spécialisées comme celles que fabrique Eickhoff (ESA 60, ESA 150, ESA 300), Westfalia (VME et dérivées) et DOSCO (In-Seam Miner - ISM 2000, ISM 3000).

La mise en valeur d'une exploitation borgne doit se faire avec prudence car elle est nettement plus risquée que le traçage à sens unique ou que la longue taille classique à deux issues.

La sûreté et le succès de l'exploitation par taille borgne dépendent des facteurs suivants, qui revêtent une importance critique :

- la ventilation;
- le soutènement;
- le contrôle du grisou et de la poussière;
- la surveillance;
- les communications;
- l'accès;
- la prévention de l'ignition par friction;
- le rythme de rabattage et la manutention des matériaux;
- l'effectif nécessaire.

Ces facteurs sont exposés en détail dans la section 4.2 du rapport, où l'on présente les principales considérations dont il faut tenir compte pour concevoir et faire approuver un système d'exploitation par taille borgne.

Au moment de rédiger, à notre connaissance, sept mines appliquaient le système de base ou une version du système d'ERMTB. Il s'agit des mines suivantes :

- mine Wistow (G.-B.);
- mine Sherwood (G.-B.);
- mine Mansfield (G.-B.);
- mine Allerton Bywater (G.-B.);
- mine Stolzenbach (RFA);
- mine Gretley (Australie);
- mine OCP Phosphate (Maroc).

En Grande-Bretagne, plusieurs mines de charbon souterraines ont employé la méthode de la taille borgne. Certaines de ces mines sont aujourd'hui fermées (*) et on possède peu de renseignements à leur sujet.

En voici la liste, par ordre chronologique :

1980(-85)	Whitwick*
1980	Wath*
1980	South Kirby
1982	Measham
1983	Ledston Luck*
1983	Royston Drift
1983	Pye Hill*
1984	Cadley Hill
1987	Bevercotes

Plusieurs mines, situées dans diverses régions du monde, envisagent d'adopter un système de taille borgne pour la récupération des secteurs inexploités et le dépilage, ou comme système d'exploitation principal.

Il s'agit des mines suivantes :

- mine Norgrad (Hongrie);
- mine Rheinland (RFA);
- mine Bagworth (G.-B.);
- mine Ellington (G.-B.).

On trouve dans les sections 4.3, 4.4 et 4.5 du rapport une description détaillée de ces mines, qui complète le sommaire présenté au Tableau 1.

Il vaut cependant la peine de souligner que le record de production et de productivité d'une exploitation par moyenne taille borgne appartient à la mine Wistow de la British Coal, qui a produit 26 928 t en 15 postes à partir d'une taille de 35 m de long mobilisant 5 hommes par poste, soit un rendement par poste d'ouvrier (RPO) de 360 t.

L'une des variantes possibles du système de base consiste à employer une machine à tracer pour percer la voie de base et la ligne de taille, puis à abattre le front court en rabattement. La méthode n'a pas encore été expérimentée en pratique, mais trois marques fabriquent du matériel qui devrait répondre au besoin.

Il s'agit des marques et machines suivants :

- o DOSCO (G.-B.) - In Seam Miner - ISM 2000
  - ISM 3000
- o Eickhoff (RFA) - Haveuse-chargeuse ESA - ESA 60
  - ESA 150
  - ESA 300
- o Westalia (RFA) - Houilleuse-traceuse - VME

Les machines en questions sont généralement moins puissantes que la haveuse classique et permettent un rendement maximal de l'ordre de 14 000 t par semaine quand on s'en sert pour exploiter des tailles courtes.

Le choix d'une haveuse classique ou d'une houilleuse-traceuse pour l'exploitation par taille borgne dépend de trois facteurs qui varient selon la mine :

- o l'évaluation du rendement que doit donner la taille rabattante;
- o les émissions de grisou et la nécessité d'utiliser des tambours ventilés (dotés d'un système rotatif de circulation d'air), dont ne sont pas dotées les traceuses;
- o les capitaux et l'équipement disponibles.

La décision finale ne peut être prise que par la mine qui veut se lancer dans l'exploitation de cette nature.

Comme l'illustre la Tableau 2, il y a très peu de différence entre l'exploitation d'une taille borgne au moyen d'une haveuse classique et au moyen d'une machine ESA ou VME.

L'emploi d'une même machine pour le traçage et l'abatage présente les avantages suivants :

- nettes économies de temps et d'argent, étant donné qu'il n'y a pas besoin de démonter et de retirer le matériel de traçage;

- utilisation plus rationnelle du matériel;

- on peut équiper la taille de soutènement marchant pendant le traçage, car il n'est pas nécessaire de retirer la machine après ce travail;

- investissement moindre, puisqu'on n'achète qu'une machine au lieu de deux.

Les inconvénients sont les suivants :

- productivité moindre par unité de longueur de front, de soutènement marchant et de capital investi;

- la méthode n'a pas encore été expérimentée en Europe, en Amérique du Nord, ni en Australie;

- les exploitants préfèrent presque toujours employer une machine différente pour l'exploitation de la taille courte rabattante;

- les traceuses possèdent rarement des tambours d'extraction ventilés pour le contrôle de la poussière et l'élimination du grisou autour du tambour de havage, et autres caractéristiques du même genre.

Nous avons présenté dans le Chapitre 5 du rapport une série de lignes de conduites relatives à la conception, au tracé, à l'équipement et à l'exploitation de la zone retenue dans la mine Prince; on y trouve notamment les devis du matériel qui, selon nous, permet l'exploitation la plus sûre et la plus efficace. Nous sommes cependant conscients que les tailles qui serviront à tester le système feront plus largement appel au matériel que possède déjà la SDCB.

Nous avons donc évalué l'effet qu'aurait l'emploi du matériel actuel sur les plans de la sécurité et de la productivité.

La conception, le tracé et l'équipement définitifs de la taille borgne devront faire l'objet d'une étude plus détaillée, qui demandera au personnel et aux ingénieurs de l'administration centrale de la SDCB et de la mine Prince une participation plus directe que ne le permettait ni ne l'exigeait la présente étude.

Nous discutons en détail les éléments critiques d'une exploitation par taille borgne à la mine Prince dans le Chapitre 5 du rapport. En voici les points saillants :

- le secteur d'exploitation retenu;
- le tracé de base;
- le soutènement;
- le matériel de traçage;
- le matériel d'exploitation;
- l'aérage;
- la main d'oeuvre;
- la production et la productivité;
- l'installation, la récupération et le transfert du matériel.

Le secteur d'exploitation retenu

Nous avons considéré que la mine Prince était la seule qui convenait à l'application initiale de l'exploitation par taille borgne (les émissions de grisou étant trop élevées dans les mines Lingan et Phalen) et que le secteur compris entre les chantiers de longue taille et la côte présentait les conditions les plus avantageuses. Au sein du secteur retenu, nous avons sélectionné un périmètre de 1 000 m x 1 600 m pour les premiers travaux, entre autre parce qu'il se situait près des voies d'accès et des services actuels.

Le tracé de base

Avant de préciser la géométrie des tailles et des chambres, nous avons évalué la géologie du secteur, la qualité du massif rocheux, la résistance du roc intact et la répartition des contraintes.

Comme le secteur retenu pour l'exploitation par taille borgne dans la mine Prince se situe entre 55 m et 140 m sous le fond de la mer, le contrôle des affaissements de "surface" constituait le premier critère de conception. La politique de la SDCB en matière de conception limite à 8,5 mm/m la déformation unitaire au fond de mer. On a respecté cette exigence dans la cadre de la présente étude, ainsi que l'épaisseur réglementaire du mort-terrain qui doit recouvrir toute zone d'extraction.

Nous avons élaboré des profils de déformation à l'aide du logiciel mis au point par le laboratoire de recherche houillère de Cap Breton, en fonction de diverses largeurs de chambres et de

piliers, et de diverses épaisseurs de mort-terrain. Les profils ont révélé que la largeur des chambres et l'épaisseur du mort-terrain constituaient les paramètres critiques. Nous avons aussi élaboré les profils de contrainte des piliers situés entre des tailles adjacentes, pour en arriver aux dimensions suivantes :

Épaisseur du mort-terrain (m)	Largeur de la chambre (m)	Longueur de la taille (m)	Largeur du pilier (m)
60 - 75	30	25	30
75 - 100	30	25	20
100 +	35	30	30

Le ratio d'extraction dans le secteur est de 56 p. 100, ce qui représente quelque 2,75 Mt de charbon pour 28 tailles borgnes.

Nous avons pris en compte les facteurs suivants pour déterminer le tracé des chambres borgnes :

- l'épaisseur du mort terrain au dessus du charbon;
- le pendage de la couche;
- la présence ou non de schistes argileux;
- la nature du toit.

Pour déterminer l'orientation des tailles, les facteurs primordiaux sont le pendage de la couche et l'utilité de rabattre la taille vers le pied, pour un meilleur contrôle du grisou. Cette technique contribue en effet à retenir les gaz dans la zone de déblai. De même, pour évaluer si la taille doit monter ou descendre par rapport à la voie de base, on a considéré plusieurs facteurs :

- l'aérage et le contrôle du grisou;
- la facilité d'exploitation;
- la direction d'acheminement de la houille;
- les problèmes de soutènement et de stabilité qui pourraient surgir à l'intersection de la taille et de la voie de base.

Le contrôle du grisou est, de loin, le facteur le plus important; on a donc situé les tailles au pied de la voie de base, afin que le grisou s'écoule vers la galerie d'accès, où il est plus facile de s'en débarrasser que s'il s'accumule sur le front de taille. En outre, il est plus facile de maintenir la voie de base en bon état si elle est en tête de la taille plutôt qu'en pied.

Les principaux facteurs qui limitent la longueur de chambre que l'on peut exploiter sont la distance sur laquelle on peut efficacement aérer la taille borgne et la nécessité, pour des raisons de sécurité, d'en éliminer tout système d'entraînement intermédiaire et tout point de transfert. À la mine Prince, on sait par expérience que l'on ne peut pas aérer de façon sûre une galerie borgne de plus de 1 000 m. Nous avons donc retenu cette distance comme limite des chambres aux fins de la présente étude.

La largeur de la galerie est dictée par le dégagement du matériel (5 m), particulièrement en front de galerie, et par des considérations de contrôle du toit. Les études relatives à ce dernier facteur indiquent qu'une largeur de 5 m est acceptable pourvu que la paroi latérale de la galerie colle d'aussi près que possible le soutènement. Comme il n'est pas toujours possible de respecter cette condition, nous estimons qu'il serait beaucoup plus sûr d'installer des boulons d'ancrage entre les cadres d'acier.

La Figure 4 illustre le tracé proposé pour le chantier d'exploitation par taille borgne, en fonction des critères énoncés ci-dessus.

o <u>Le soutènement</u>

Les normes de soutènement sont beaucoup plus strictes dans un système de galeries borgnes à cause de l'accès unique au front de taille et des conséquences que toute instabilité du terrain peuvent avoir sur la voie d'accès et la taille.

L'étude des contraintes, de la qualité rocheuse, de l'activité minière, des conditions rencontrées et des normes en vigueur dans la mine, ainsi que la nécessité d'employer un soutènement "actif", ont démontré, d'une part, que le système actuel de soutènement par cadres d'acier était satisfaisant si l'on installait les cadres à intervalles de 0,9 m dans une galerie de largeur correcte et, d'autre part, qu'un système de courroies et de treillis d'acier fixé à tous les 1,0 m par des boulons d'ancrage constituerait un soutènement sûr. Toutefois, en ce qui concerne les galeries, nous avons recommandé d'utiliser dans le traçage initial des cadres d'acier placés à 1,0 m d'intervalle et séparés par des boulons d'ancrage, quitte à étendre l'intervalle entre les cadres une fois que l'on aura acquis plus d'expérience.

Les conditions observées dans les longues tailles existantes de la mine Prince indiquent que les boucliers de 320 t permettent de soutenir une charge de 59 t/m^2. Nos calculs ont révélé que le soutènement nécessaire dans le secteur de taille borgne est de 26 t/m^2. Nous avons donc recommandé d'employer les boucliers existants dans les tailles borgnes, mais avec un réglage et un point de coulissement inférieurs.

- Le matériel de traçage

Nous recommandons d'utiliser la traceuse VME de Westfalia, équipée d'un soutènement marchant, pour creuser la galerie borgne et la ligne de taille, car elle permet de haver et d'installer le soutènement en une seule opération, et en particulier parce qu'elle ouvre une galerie de largeur constante bordée de parois verticales, ce qui permet d'en contrôler la configuration de près. Le reste du matériel doit être le même que celui dont on se sert pour desservir la taille rabattante.

- Le matériel d'exploitation

Pour la taille, nous recommandons l'emploi d'une haveuse à tambour unique réglable en hauteur montée sur blindé à rouleaux curviligne avec conduit d'aérage intégré. Le convoyeur de tête doit être du type modulaire en couche avec dispositif de mise en réserve et de tension de courroie automatique et touret d'une capacité de 100 m. La station de pompage du soutènement hydraulique doit être située à l'extérieur de la galerie borgne et le transport des matériaux doit se faire par tracteur.

On doit tenter par tous les moyens de simplifier la conception, d'employer un minimum de matériel et d'installer le moins de machines possible dans la galerie borgne et la taille.

- L'aérage

Nous proposons un système d'aérage forcé basé sur un ventilateur primaire de 90 kW et un ventilateur secondaire de 37,5 kW, ce dernier étant placé au front de taille. Le système doit assurer une circulation d'au moins 5,0 m^3/s au front borgne de la taille. Compte tenu du taux d'émission de grisou que l'on observe actuellement à la mine Prince (0,26 m^3/t), ce système devrait diluer le grisou à un niveau

acceptable (0,40%) sur le front de taille quand la production atteindra un rendement d'environ 1330 t/poste sur une taille de 25 m.

Comme l'illustre la Figure 5, il est nécessaire de mettre en place un système de surveillance et de contrôle très complet.

o Main d'oeuvre et production

L'exploitation normale d'une taille borgne demande 5 personnes, à savoir :

haveuse	2
soutènement	1
front de taille	1
supervision	1

On partage un électricien et un mécanicien avec les équipes de traçage voisines, de même que les préposés à l'évacuation du minerai.

Si la haveuse est une machine de 300 kW et que celle-ci est productive pendant 40 p. 100 de la durée du poste, la taille devrait produire 1330 t/poste (soit 3390 t/jour ou 17 950 t/semaine) et se rabattre à un rythme de 14,6 m/poste (soit 43 m/jour ou 216 m/semaine).

La production maximale serait de 990 t/h et le rendement prévu du quartier et de la taille par ouvrier-poste seraient respectivement de 169 t/o-p et de 147 t/o-p.

o L'installation, la récupération et le transfert du matériel

Selon l'expérience acquise, dans les conditions que l'on trouve actuellement à la mine Prince, le meilleur moyen pour exécuter ces opérations consiste à employer des tracteurs. Leur durée totale ne devrait pas dépasser deux semaines.

o Les considérations réglementaires

On discute à la section 5.11 du rapport les règlements qui régissent l'approbation et l'application du système d'exploitation par taille borgne.

- Les coûts

Nous avons dressé une comparaison des avantages financiers de la méthode en nous basant sur les données communiquées par la SDCB et les fabricants de matériel.

L'exploitation d'une taille borgne demande l'acquisition de matériel d'une valeur de 0,75 M$, alors que l'exploitation par taille rabattante, pratiquée actuellement à la Prince, mobilise du matériel d'une valeur de 3,0 M$. Le nouveau système représente donc une économie de 2,25 M$ environ.

Les frais d'exploitation d'une taille borgne sont inférieurs, la productivité étant plus grande. On estime que les frais d'énergie et de transport sont les mêmes dans les deux cas. Si l'on écarte la possibilité d'un changement de prime et si l'on tient compte de la main d'oeuvre et du rendement, il semble probable que l'on puisse économiser 0,70 $/t (soit 630 000 $ par an).

- Devis sommaire

Le Tableau 3 résume les devis relatifs aux critères et à l'équipement dont nous recommandons l'utilisation dans l'exploitation rabattante par moyenne taille borgne à la mine Prince.

CONCLUSIONS

Dans le cadre de la présente étude, nous avons examiné les systèmes d'exploitation rabattante par moyenne taille borgne (ERMTB) qui sont ou ont été utilisés dans des mines de houille souterraines partout dans le monde, ainsi que les conditions et les opérations dans les mines de la CDCB.

Nos observations nous mènent aux conclusions suivantes.

1. Le système d'ERMTB est en usage depuis plus de 8 ans; il a prouvé son efficacité et sa sûreté dans 16 des 17 mines où on l'a mis en application.

2. Le système d'ERMTB peut servir à l'exploitation de piliers ou de zones intactes, pour le dépilage partiel et comme système d'exploitation principal.

3. Le succès et la sécurité du système d'ERMTB exigent l'application et le respect des plus strictes normes d'aérage et de soutènement, ainsi que des procédés d'exploitation classiques.

4. Il importe de surveiller de près les facteurs environnementaux dans la chambre.

5. Le système d'ERMTB doit faire appel au moins d'élément possible, et doit demeurer le plus simple possible.

6. On doit limiter le plus possible le nombre de machines dans la galerie borgne.

7. Le contrôle du grisou constitue le premier facteur de sécurité du système.

8. Le soutènement de la galerie borgne et de la jonction de la taille avec la voie de base est aussi critique.

9. Le système d'ERMTB peut donner un rendement très élevé et contribuer à rentabiliser la mine.

10. Le système d'ERMTB impose de lourdes contraintes aux opérations de traçage et exige que ces opérations soient organisées, menées et surveillées avec un soin égal, sinon supérieur, à celui qui préside aux opérations de taille.

11. À la mine Prince, la condition du toit est assez bonne, les normes d'exploitation sont assez élevées et le taux d'émission de grisou est assez faible pour que l'on puisse appliquer le système d'ERMTB avec le meilleur pronostic en matière de rendement et de sécurité.

12. Quoiqu'il demeure certaines zones intactes dans les mines Lingan et Phalen, les conditions, les normes et les taux d'émission de grisou sont tels qu'il serait prématuré d'y appliquer le système d'ERMTB pour le moment.

13. Le système d'ERMTB peut être appliqué au moyen de machines différentes pour le traçage de la galerie et de la taille d'une part et pour l'abattage en rabattement d'autre part, ou au moyen d'une même machine pour les deux opérations. Dans le dernier cas, qui n'a pas encore été expérimenté, on doit s'attendre à une plus faible productivité de l'abattage.

RECOMMANDATIONS

1. On devrait appliquer le système d'exploitation rabattante par moyenne taille borgne à la mine Prince, dans la zone désignée, entre la côte et les longues tailles situées à l'Ouest des voies de fonds.

2. La mine Prince et le personnel de la SDCB de Glace Bay devraient élaborer une conception détaillée du système en se basant sur les lignes de conduites présentées dans notre rapport, et modifiées en fonctions des exigences réglementaires et du matériel disponible. Leur projet devrait être examiné avant mise en oeuvre.

3. L'exploitation initiale devrait être basée sur l'emploi d'une haveuse pour le traçage des galeries et des lignes de taille, et d'une abatteuse pour la taille rabattante proprement dite. Une fois démontrée l'efficacité du système, on devrait envisager d'utiliser une seule machine pour les deux opérations.

4. Le soutènement de galerie devrait comprendre l'installation complémentaire de boulons d'ancrage (de type Swellex) dans un premier temps. Après un certain temps, quand on aura évalué le rendement du système mixte, on devrait envisager d'adopter un système d'ancrage simple.

5. L'organisation d'un stage de formation destiné aux cadres et aux employés, prévoyant entre autres la mise en place du système en surface dans le cadre du processus d'homologation, devrait nécessairement accompagner l'adoption du système d'ERMTB.

6. Il importe de documenter en détail les opérations initiales du système d'ERMTB afin que l'on puisse cerner les causes des problèmes, apporter les correctifs nécessaires et modifier la conception du système en conséquence. Ceci devrait faire l'objet d'un examen indépendant.

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PART 1

INTRODUCTION

PART 1 - INTRODUCTION

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1.0 INTRODUCTION

1.1 BACKGROUND

In September 1987, Supply and Services Canada awarded a contract, on the behalf of the CANMET Cape Breton Coal Research Laboratory in Sydney, to Monenco Consultants Limited to prepare a review report on the possible application of Single Entry Short Longwall Retreating Systems for the mining of broken workings in the undersea mines of the Cape Breton Development Corporation in the Sydney (Nova Scotia) coalfields.

This report presents the results of the investigations undertaken by Monenco, assisted by Obed Mountain Coal and Golder Associates, in accordance with the objective and scope of work summarized in the section following.

1.2 OBJECTIVE AND SCOPE OF WORK

1.2.1 Objective

The objective of this work is to review the possible application of single entry short longwall retreating faces as a practical and productive method of mining under certain circumstances and conditions that prevail within the Sydney Coalfield in Nova Scotia, Canada.

1.2.2 Statement of Work

1. Through literature search, telephone conversation, correspondence and discussion with appropriate mine operators, manufacturers and equipment suppliers and with staff of the CBDC to review possible site specific applications for short longwall single entry retreat faces within the operating mines of CBDC.

2. From the review made in (1) to determine for each site application:

   (a) The dimensions for single entries.
   (b) The panel lengths.
   (c) The panel widths.
   (d) The panel/pillar ratios for effective ground control.
   (e) The direction of panel workings with respect to gradient and other factors.
   (f) A system and the equipment to ensure the provision of adequate ventilation.

(g) The advantages of the system.
(h) The disadvantages of the system.
(i) The safety.
(j) The effective support of the single entries.
(k) The effective support of the short face panels.
(l) The cost effectiveness.
(m) The productivity.
(n) The selection of compatible equipment that acknowledges: i) the safety, l) the cost effectiveness and m) the productivity.

3. To make recommendations on the applications of the system to site specific conditions in the Sydney Coalfield.

4. To prepare a final report containing Executive Summary, Introduction, Discussion, Conclusions and Supporting Graphs, Tables and Figures. The Executive Summary will be in both English and French.

1.3 ACKNOWLEDGEMENTS

Monenco wishes to acknowledge the help and guidance received from the CANMET Scientific Authority for the study, Mr. George Haslett, Manager, Coal Research Laboratory, Sydney, N.S.

In particular, we wish to thank Mr. Roy MacLean, Director Engineering Services and Mr. Bob Cooper, Vice President Mining Operations and the staff of the Cape Breton Development Corporation for facilitating underground visits and discussions and for freely providing their time and information.

We are especially indebted to the Mine Managers and the staff of the Prince, Lingan, Phalen, Wistow, Sherwood and Zodler Mines for the very useful visits and discussions, and to Dr. H. Boldt of the Neiderrhein Division of Ruhrkohle AG for providing data on the Rheinland Mine design.

In the U.K. and West Germany, our thanks are due to Mr. John Straughan of Dosco, Herr Peter Eickhoff of Eickhoff and Herr Hans Leppke of Westfalia for all the arrangements they made and the information provided.

Finally, we acknowledge the valuable help we received from Dr. M.B. Jones, H.M. Chief Inspector of Mines and his staff on regulatory and safety aspects of the systems in use in the U.K., and the many U.K. and German equipment manufacturers who made themselves available for discussions and provided much useful information.

PART 2

STUDY METHODS

PART 2 - STUDY METHODS

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2.1 GENERAL

The work was undertaken by a small team led by Mr. Ian Muirhead, Manager of Monenco's Mining department and an internationally experienced underground mining engineer. He was assisted by Mr. Allan McGowan, Maintenance Manager, Obed Mountain Coal (Mining Equipment) and Mr. Allan Moss, Associate, Golder Associates (Strata Control and Panel Design).

The methods employed to carry out the investigation are outlined below.

2.2 STUDY METHODS

The work was divided into a number of tasks.

2.2.1 Task 1: Mine Visits and Discussions (Canada)

Since the purpose of the study was to review site specific applications for short single entry longwall retreat faces within the operating mines of the CBDC, discussions were held with management, operational, engineering, and maintenance staff at CBDC, visits made to the three operating mines (Prince, Lingan and Phalen), and discussions held with the Mines Inspectorate in Sydney.

The purpose of the discussions and mine visits was to ensure that: the conditions to which the single entry systems were to be applied were fully understood; the expectations, preferences and requirements of CBDC staff were appreciated; the type and make of equipment currently in use and planned for the immediate future were identified; details of the present methods (if any) of mining broken workings were obtained; the particular problems, if any, associated with their use in the coalfield conditions in Cape Breton were understood and the regulatory implications clarified.

2.2.2 Task 2: Literature and Review and Data Collection

Three methods were used to collect the required information on short single entry longwall retreating systems. These were:

- Literature search through computer databases and inhouse files;
- Requests to equipment and systems manufacturers for basic information; and

- Follow-up questionnaire to manufacturers, research associations and selected operating mines.

Literature Search

This took place in two steps:

(a) Use was made of Monenco's extensive library facilities to undertake searches of the relevant mining and technical databases using selected key words appropriate to subject matter under review, and included the following databases:

- MNT - CANMET's mining technology and database which covers mining technology and related projects.
- MTCH - Mining Technology Clearing House, U.K., accessed through CAN/OLE coal projects file covering mining and technological subjects.
- OON - The database of the Canadian Institute for Scientific and Technical Information (CISTI).
- NTIS - The National Technical Information Service offered as a database through the US Department of Commerce. This incorporates over one million records of publications resulting from government funded research development and engineering research including that related to mining.
- COMPENDEX - Engineering Index's worldwide coverage of engineering and technological literature. This is a major source for general articles in mining fields.
- EI Meetings - Papers from meetings and conferences on engineering methods including mining.
- IEA COAL - IEA - A worldwide Coal Research database, including Coal Abstracts (1978-present).
- MINSYS - Which provides international coverage of mining topics.

(b) There are always a number of important articles and papers from International Mining Journals that do not appear in database searches, usually because of incorrect key wording. The reference library at the Canadian Institute of Scientific and Technical Information in Ottawa receives and retains copies of almost all of the important mining journals that are published around the world. A manual search of the international mining journals retained there was undertaken.

Data from Equipment Manufacturers

Contact was made with the manufacturers of longwall face equipment with particular emphasis being placed on those companies which have supplied short longwall retreating systems.

Data Collection from Other Suppliers, Mining Companies and Research Institutions

In addition to the above searches, a questionnaire was developed which listed the information being sought, and this was sent to mines which had used, were using or were known to be investigating the single entry short longwall retreating system. It was intended that this questionnaire would supplement the visits program proposed in Task 3. Mines in UK, West Germany, Morocco, Australia and Europe were contacted. Contact was also made with USBM (Pittsburgh, Twin Cities and Denver Research Centres), ACIRL and CSIRO (Australia) and Bergbauforschung (FRG) to determine what consideration was being given in those countries to the use of single entry faces. Information was also sought from Mines Inspectorates in countries where the system is used, to determine what exemptions or changes (if any) have had to be made to existing legislation to accommodate the single entry system.

2.2.3 Task 3 - Visits and Discussions (Europe)

The single entry longwall face is a relatively new and unique application of longwall mining technology and is believed to have been first applied in England in the 1980. It requires a rethink on strata control, security of access to working face, provision of all face services in a single roadway, equipment types and compatibilities of several sequential operations and provision of adequate ventilation especially on the face. Some of these are a major departure from current practice, and since it is still a relatively new and not yet widespread technique, visits were made to existing operations to discuss these salient features with the mining personnel who have experienced the problems and developed the answers.

The visits program was designed to access operating data on single entry faces using (a) standard equipment (Selby & Sherwood UK);

(b) Eickhoff ESA type machines (Zolder, Belgium); (c) Westphalia VME miner (Phalen Mine, N.S.); (d) Dosco In Seam Miner (Sherwood, UK); (e) new developments in single entry face support and ventilation handling (Kloechner Becorit, FGR); planned single entry systems in Germany (Ruhrkohle) and regulatory aspects of same (HMIM, UK).

2.2.4 Task 4 - Data Analysis and System Selection

The data which was obtained from the various sources was collated and used to determine, for the identified CBDC site, the most appropriate answers to items 2(a) to 2(m) as stated in Section 2 of the Statement of Work. In providing these responses, the following was taken into account for the relevant item.

(a) Dimensions for 'Single Entries'

- o dimensions required for ventilation;
- o dimensions required to contain all face services in one heading;
- o seam height;
- o roof and floor strata strength;
- o seam depth;
- o dimensions of drivage equipment; and
- o dimensions of equipment required at face.

(b) Panel Lengths

- o size of available broken working area;
- o ventilation considerations;
- o regulatory restrictions; and
- o gradients and transport capacities.

(c) Panel Widths

- o size of available broken working area;
- o coal face machinery limitations in power and capacity;
- o ventilation considerations, especially ducting through face and methane dilution; and
- o strata control considerations - depth, old workings, pillars, etc.

(d) Panel/Pillar Ratios for Effective Ground Control

- o strata control considerations (as above).

(e) Direction of Panel Workings

- o gradient;
- o size and orientation of broken working area; and
- o mine ventilation system and methane and water control.

(f) Ventilation System

- o methane emission;
- o roadway and face dimensions;
- o ability to ventilate face through supports;
- o monitoring and control systems;
- o dust control; and
- o need for overlap systems.

(g) Advantages

- o as determined.

(h) Disadvantages

- o as determined.

(i) Safety

- o ability to maintain access and egress;
- o control of hazards - methane, water, strata control, congestion;
- o congestion in roadway and on face; and
- o control and limits on manpower.

(j) Effective Entry Support

- o strata control considerations;
- o face/entry area problems and support.

(k) Effective Face Support

- o strata control considerations;
- o compatibility with entry support;
- o face/entry area problems;
- o transport and installation requirements; and
- o control systems.

(l) Cost Effectiveness

- o development cost;
- o production costs;

- o benefits of lower manning, higher productivity; and
- o equipment utilization.

(m) Productivity

- o as identified.

An evaluation of the above was made for each agreed site, and recommendations were made for equipment, layout, method, manning, production, etc. for each site. These recommendations also took into account such other aspects as:

- o suitability to Cape Breton conditions;
- o compatibility with existing equipment and mining methods;
- o installation and maintenance requirements and facilities and skills necessary to maintain and operate equipment;
- o compliance with Canadian Safety Regulations;
- o establishment of training requirements and management control techniques;
- o any concerns in labour force in working in single entry access in moving ground;
- o need for condition monitoring of equipment;
- o need for display of data (alpha-numeric, graphic) and at what locations; and
- o suppliers back up service and spares availability and cost.

2.2.5 Task 5 - Study Reports

A draft report was prepared which presented the study methodology and data; the task reports which commented on the various methods and systems suitable for application of short single entry longwall retreating faces for the specific sites with CBDC mines; and the proposals for each site. Conclusions were drawn, and recommendations made for the system(s) suitable for application in the Sydney coalfield. The draft report was submitted for review and comment and relevant comments and other data were incorporated and the final report issued.

PART 3

CAPE BRETON DEVELOPMENT CORPORATION
MINES & POTENTIAL SITES

PART 3 - CAPE BRETON DEVELOPMENT CORPORATION MINES & POTENTIAL SITES

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3.1 CAPE BRETON DEVELOPMENT CORPORATION (CBDC)

Coal mining has been a way of life in Cape Breton, an island at the north eastern edge of Nova Scotia, since the French regiments mined coal in the early 1700's.

The Government of Canada expropriated the assets of the Dominion Coal Company, which was operating the coal mines on Cape Breton Island, in 1968 in order to prevent the closure of an uneconomic industry. The Cape Breton Development Corporation (CBDC) was created by Act of Parliament to operate the coal mines, coal preparation plant, railway and shipping pier previously owned by Dominion Coal. CBDC retained only one of the original Dominion Mines - No. 26 (since closed in 1984 following a disastrous fire) and has opened three new mines. There are the Prince mine (1976) at Pt. Aconi, the Lingan mine (1972) at Lingan and the Phalen mine (1987) also at Lingan. In addition, CBDC has developed the twin access tunnels for the Donkin-Morien mine at Pt. Perce. This development is currently on hold.

The Corporation controls the leases for the coal in the Sydney Coalfield. The Coalfield contains eleven seams of high volatile bituminous "A" coal. There are four major seams, Lloyd (3.1 m), Hub (2.3 m), Harbour (2.1-4.2 m) and Phalen (1.5-2.1 m). Of these, the Hub seam is only worked at the Prince mine, the Harbour seam at the Lingan mine, and the Phalen seam at the Phalen mine. The mines are designed to produce a total of between 4 and 5 million tonnes per year.

The location of the mines is shown on Figure 3-1, and brief descriptions of each mine are given in the following sections.

3.2 PRINCE MINE

Prince Mine is an undersea mine working the Hub Seam. Early mining in 1976-1977 was by room and pillar methods under the Pt. Aconi peninsula. This was not successful, primarily due to extremely soft floor conditions. The mine access slopes were extended under the sea and, beyond the 167 m cover contour about 4 kms from the portal, short retreating longwall faces were established commencing production in May 1980. These were successful and the method has been continued.

The mine (Figure 3-2) is designed to produce 25,000 t/week from a single retreating longwall face and several development headings for extension of the main slopes and for new faces.

The mine operates 15 8-hour shifts per week and employs 670 men. The Hub Seam averages 2.3 m in thickness, but varies from 1.8 m

to 2.45 m according to the presence or otherwise of a rider seam, generally being thicker in the western part of the take.

The main ventilation is provided by two 60 m^3/s single inlet, single width variable pitch air-foil blade fans operating in parallel. The fans are located at the top of a return air shaft, itself located close to the coastline. The fans generate a maximum water gauge pressure of 25 cms.

Coal from the working face and development headings is conveyed on 0.91 m belt conveyors to the main slopes where it is tranferred to 1.07 m conveyors which take it to a 450 tonne silo on the surface. The coal is then dispatched by truck to Sydney Mines where it is loaded into railway cars for shipping to either thermal generating plants in the province, or to the CBDC Victoria Junction coal preparation plant for processing.

A brief summary of a typical short longwall retreat face and a development heading at the Prince mine are given in Tables 3-1 and 3-2. Table 3-1 gives details of the methods and equipment used on the currently operating 6 West longwall face, whilst Table 3-2 gives details of those in use in 7 West main gate development.

General comments include:

1. Sandstone washouts and/or rolls cause problems;

2. Immediate floor in present working area is hard mudstone;

3. Immediate roof of shale/mudstone/siltstone (5 m) with sandstone above;

4. Main deeps driven by Dosco Mk 2A and 2B roadheaders;

5. Maintenance on "as required" basis with repairs scheduled for weekend.

6. Maximum length of roadway driven on auxiliary ventilation is 900-1000 m.

It can be seen from Figure 3-2 that a large reserve of coal exists in the unmined area between the initial room and pillar workings (approximately at the shoreline) and the commencement of the retreat longwall workings. This is between the 55 m and 167 m cover line and contains some 20 Mt of coal which could be recovered by some form of partial extraction.

Since ground control and strata conditions will be critical to the mining of this area, the following comments on the conditions observed in the mine during the underground visit are relevant.

- Seatearths are present in the floors. These seatearths have their thickest development in abandoned room and pillar section of the mine, (i.e. shallow depths) where up to 0.3 m may be present. The seatearths thin with depth. Caused major trafficability problems during room and pillar mining.

- Geologic "hazard" plans available showing different roof conditions.

- Experience indicates that where sandstone roofs are present, heavier conditions may exist.

- Large sandstone washout cuts coal block.

- Roofs in vicinity of these washouts tends to be weak.

- Problems of coal splitting - rider coal seam may give rise to "heavy" roof.

- "Simple" joint structure system, bedding plus 2 near vertical sets.

- Maximum stress direction parallel to cleat.

- Stress problems when driving deeps.

- Panel and rib pillar dimensions based largely on subsidence requirements. At 167 m depth, approximately 80 m wide panel are used with 65 m ribs, while at 200 m depth, 120 m panels are used with 65 m pillars.

- 320 tonne shields on face at depth of 230 m equivalent to capacity loading of 59 t/m^2.

- Stress abutment approximately 60 m ahead of face.

- Slopes appear to be oversupported since many arches do not appear to be providing effective support due to point loading.

- Steel sets on 0.9 m centres used on both gate roads.

- Blocking of the sets in gate roads could be improved and thus the effectiveness of support increased. Friction bolts and straps or lacing may be a viable support method.

- Problems of stone bands in face. These bands may be up to 20 cms. thick.

3.3 LINGAN MINE

Lingan Mine is now the oldest of the undersea mines operated by CBDC. Development of the mine site commenced in late 1969. The access slopes to the mine commenced in 1971 and by early 1972, coal was being produced from room and pillar workings in the area to the east of the main slopes between the shoreline and the 240 m cover line. The first longwall advancing faces started in late 1976, and to date the mine has been operated on this system with faces to the east and west of the main access slopes. The mine normally has 3 working longwall faces in the Harbour Seam (Figure 3-3). The seam varies from 1.8 to 2.0 m in thickness, dipping at 8° with current workings being at approximately 600 m below seabed. The mine employs approximately 1200 men and works 15 8-hour shifts per week with a weekly saleable coal target of 30,000+ tonnes. The designed capacity of the mine is 1.45 Mt clean coal per year.

The current longwall workings are approximately 4 kms beyond the shoreline. The Lingan Mine is quite gassy and requires between 24 and 40 m^3/s of ventilation for each longwall face. Pillars, approximately 50 m wide are left between each longwall face to provide control over subsidence of the sea bed to prevent flooding of the mine and to protect gate roadways from convergence. On the east side of the mine, faces advance for up to 2600 m. For these faces, it is usually necessary to provide a cross cut through the pillar at about half distance to improve face ventilation and reduce methane concentrations. Methane drainage has also been introduced and over the past four years has proved to be very successful in reducing the amount of gas entering the ventilation circuit. The main exhausting fan is a 1350 kW single inlet, single width variable pitch air foil blade fan operating at 190 m^3/s and 46 cms water gauge.

Coal is transported from all longwall faces and developments on 0.91 m belt conveyors. These discharge onto 1.2 m conveyors in the main slopes which take the coal to the 2800 tonne silo on the surface. A 450 tonne surge bunker is installed underground prior to the slope conveyors. After crushing on the surface, coal is shipped in 90 tonne rail cars to the Victoria Junction coal preparation plant.

A brief summary of the typical longwall advancing faces working on the East (2600 m panel) and West (1300 m panel) are given in Tables 3-3 and 3-4 respectively. Table 3-3 provides details of the conventional advancing longwall on 10E face whilst Table 3-4 gives details of the 7W advancing longwall face which is using the advance heading technique in the main gate.

General comments include:

1. Advance heading being tried on 7W face to alleviate ripping problems due to thinning of the Harbour seam to 1.5 m on the west side, and with use of yielding arches, to attempt to create roadway suitable for re-use for 8W face.

2. Immediate floor strata is good mudstone, whilst immediate roof strata is mudstone and shale. The 0.3 m of strata immediately above coal often proves difficult to keep up on faces and especially at face ends.

3. Extensive use of compressed air at pit.

4. Main slopes driven by Dosco Mk 2A and 2B and Anderson Strathclyde RH25 Roadheaders.

Specific comments on ground conditions, strata control and support are:

- Similar distribution of seatearths at Prince; i.e. thicker development in shallower sections of mine.

- Stress induced failure of down dip gate road is often experienced, a result of concentration of the horizontal stress field along the leading edge of the advancing panel.

- Appears that majority of roof/floor convergence has taken place by about 60 m back from the face line.

- Solid packs placed along gobside of maingate for roof control and reduction of leakage across the face.

- Floor heave evident.

- Yielding arches being installed in maingate in advance heading taking 45 to 60 minutes to install.

- Flat top arches used in gate roads. These arches do not respond well to any eccentric loading conditions, and evidence of falls at shoulders and sides of roads due to overcutting of roadway and poor blocking indicates ground allowed to move onto arch (passive as opposed to active support) eccentrically loading arch which distorted, thus allowing further movement.

3.4 PHALEN MINE

Phalen Mine is CBDC's newest mine with site development starting in 1985.

Phalen Mine is an undersea mine developed adjacent to the Lingan Mine to work the Phalen seam some 180 m beneath the Harbour Seam workings in the Lingan Mine (Figure 3-4).

The mine commenced production from the first retreating longwall face in May 1987, the second in September 1987, and at full production is designed to reach an output of 35,000 tonnes per week. The Phalen Seam ranges from 2.45 m thickness in the East to 1.8 m in the West where the upper part of the seam splits. The mine operates 15 8-hour shifts per week and employs 590 men.

Coal is conveyed on 0.91 m belt conveyors from the longwall faces to the main slopes. A 1.40 m wide cable belt conveyor is currently being installed and this will replace the temporary series of 1.2 m belt conveyors which is presently being used to transport the coal to the surface. The coal is delivered into a 2800 tonne silo and after crushing is loaded into 90 tonne rail cars for shipment to the Victoria Junction coal preparation plant.

Summary details of the 1W retreating longwall faces, and the 2W main gate development are given in Tables 3-5 and 3-6 respectively.

General comments include:

1. Because of the need to urgently replace production lost when #26 mine was closed due to the fire, 1W face is retreating inbye along roadways still being driven.

2. Gas makes at Phalen not yet determined, but initially expected to be in the 8-15 m^3/t range.

3. Better blocking of roadway support was observed compared with Lingan. It was also noticeable that the Westphalia VME miner cut a better profile and thus side support of the roads and roadway conditions were much improved.

4. Swellex bolts were installed on 1W adjacent to the face entry. Since these were generally parallel to the strata, they were not being fully effective.

3.5 DONKIN-MORIEN DEVELOPMENT

The Donkin-Morien Mine is the next potential new mine. Twin access slopes have been driven, predominantly using a full face Lovat Tunnel Boring machine, from the surface to the intersection with the Harbour Seam. There are no working faces at the mine and any further development is currently on hold.

3.6 POTENTIAL SITES

The single entry short longwall retreating system lends itself to the recovery of (1) isolated or "broken" areas of coal which cannot be recovered economically by traditional longwall systems, and (2) the recovery of coal by partial extraction from areas where coal recovery is limited by subsidence control considerations.

A preliminary examination of the mine plans for the Prince, Lingan and Phalen mines suggests a number of areas at each mine which appear to be potential sites.

3.6.1 Prince Mine

Figure 3-5 is a coal resource map of the areas at the Prince Mine between the 55 m solid cover line and the longwall workings. The potential areas for the application of the single entry system are designated as A.B.C.&D.

In Area A between the 55 m and 90 m solid cover lines, the northern part (A_1) has a predominantly sandstone roof whilst the southern part (A_2) is predominantly shale, siltstone and mudstone.

Roof types in Areas B_1 and B_2 between the 90 m cover line and the longwall workings are similar to those in Area A_1 and A_2.

Area C encloses the coal under land, whilst Area D includes coal to the east of the main slopes. Area D is limited on its eastern boundary by deteriorating coal quality, and thinning coal seams. The coal in Area C is generally underlain by a soft fireclay ranging up to 30 cms. in thickness. This decreases in a northerly direction such that it is down to approximately 5 cms. north of the return air shaft.

The roof strata in areas A_2 & B_2 are generally devoid of major sedimentary structural anomalies, and taken with the generally thicker coals on the western side of the access slopes, are considered to be the more attractive areas in which the single entry short longwall retreating system could be initially applied.

3.6.2 Lingan Mine

From Figure 3-6, it can be seen that there are several small areas of coal which may be potential sites. These are:

(1) An area approximately 400 m by 400 m between the old 1W longwall face, the main deeps and the #14 Colliery barrier (Area 1),

(2) An area east of the main deeps between the old room & pillar workings and the 30 m cover line (Area 2),

(3) An area to the east of the old room and pillar workings to the #26 mine barrier (Area 3). The coal in this area is understood to be of poorer quality and to have structural problems and,

(4) A more remote possibility (as the mine reaches its limit) includes all the barrier pillars between the longwall faces, from which a portion may be recovered. This would require detailed consideration of the stress in the pillars, working between gas filled wastes, and likely effect on sea bed strains and subsidence.

The areas which appear to offer the most potential at Lingan are areas 1 and 2.

3.6.3 Phalen Mine

Although the Phalen Mine has only just started production, three areas could be considered as potential sites as shown on Figure 3-7. These are:

(1) An area to the west of the main slopes between 1W longwall face and the barrier to #15 Mine workings (Area I),

(2) A triangular area between the main slopes and the main deeps (Area II) and,

(3) An area between 1E longwall face and the barriers to the old Lingan Mine and to the #18 Mine (Area III).

3.6.4 Initial Site

The trials of any new mining system should always be undertaken in the best conditions available. Thus, taking into account other factors such as gradient, gas emission levels, state of mine development, standards, ease of access to potential sites, and acceptance of new technology, it is readily apparent that the Prince Mine, with its flatter gradients, lower methane emission, larger potential area for exploitation etc., offers the best potential conditions for application of the single entry system.

It was, therefore, decided that Areas A_2 and B_2 (Figure 3-5) at the Prince Mine would be used as the prime areas for establishing the layout and design of a single entry short longwall retreating system. This is discussed in detail in Part 5 of this report.

At this stage, neither the Lingan Mine nor the Phalen Mine can be considered suitable for the application of the single entry system. This is primarily due to the high methane emission rates present at the mine. No single entry system is operating in mines with equivalent high emission rates. This situation should be reviewed once experience has been gained at the Prince Mine where emission rates are similar to those experienced in mines operating the single entry system.

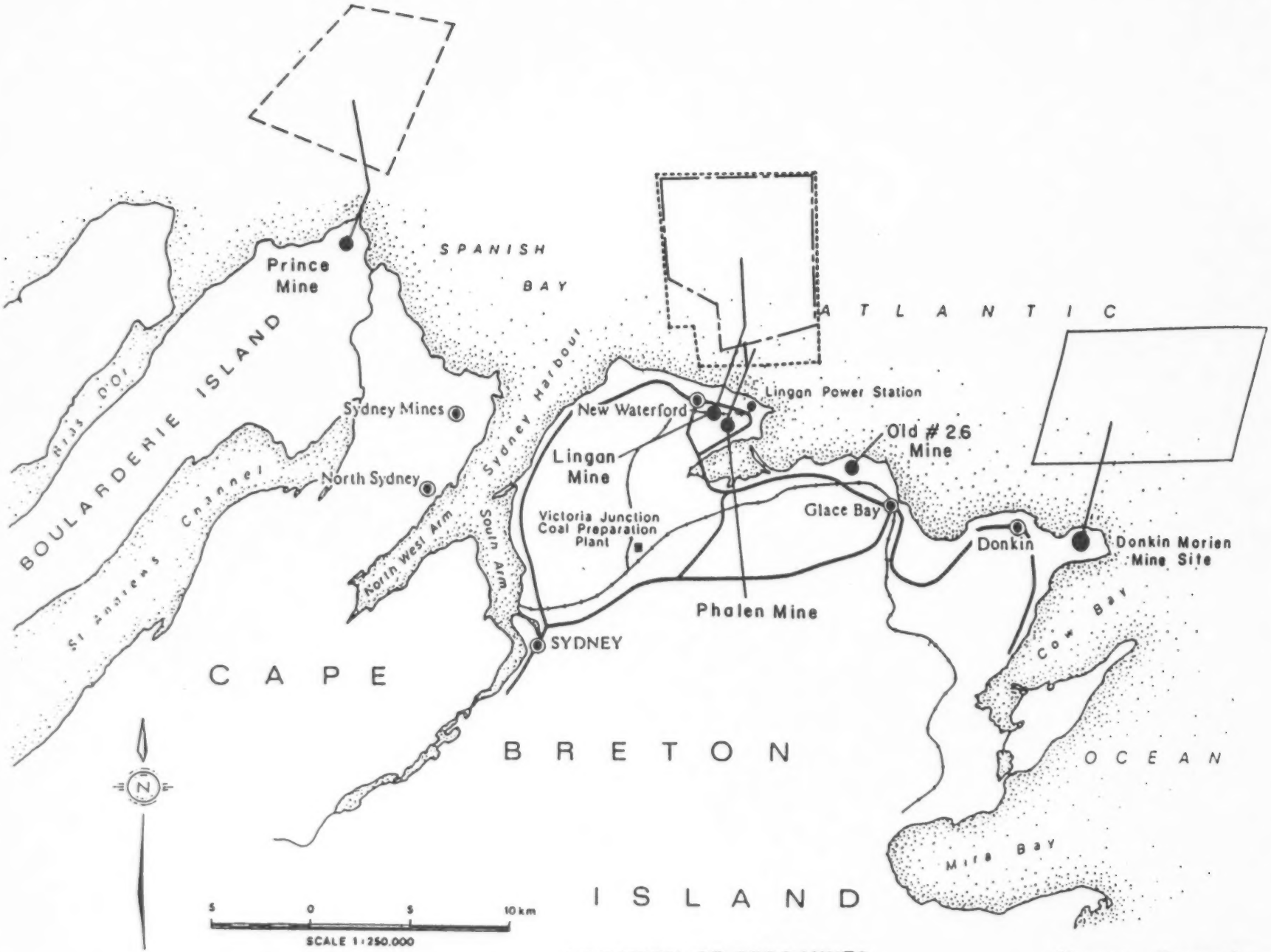
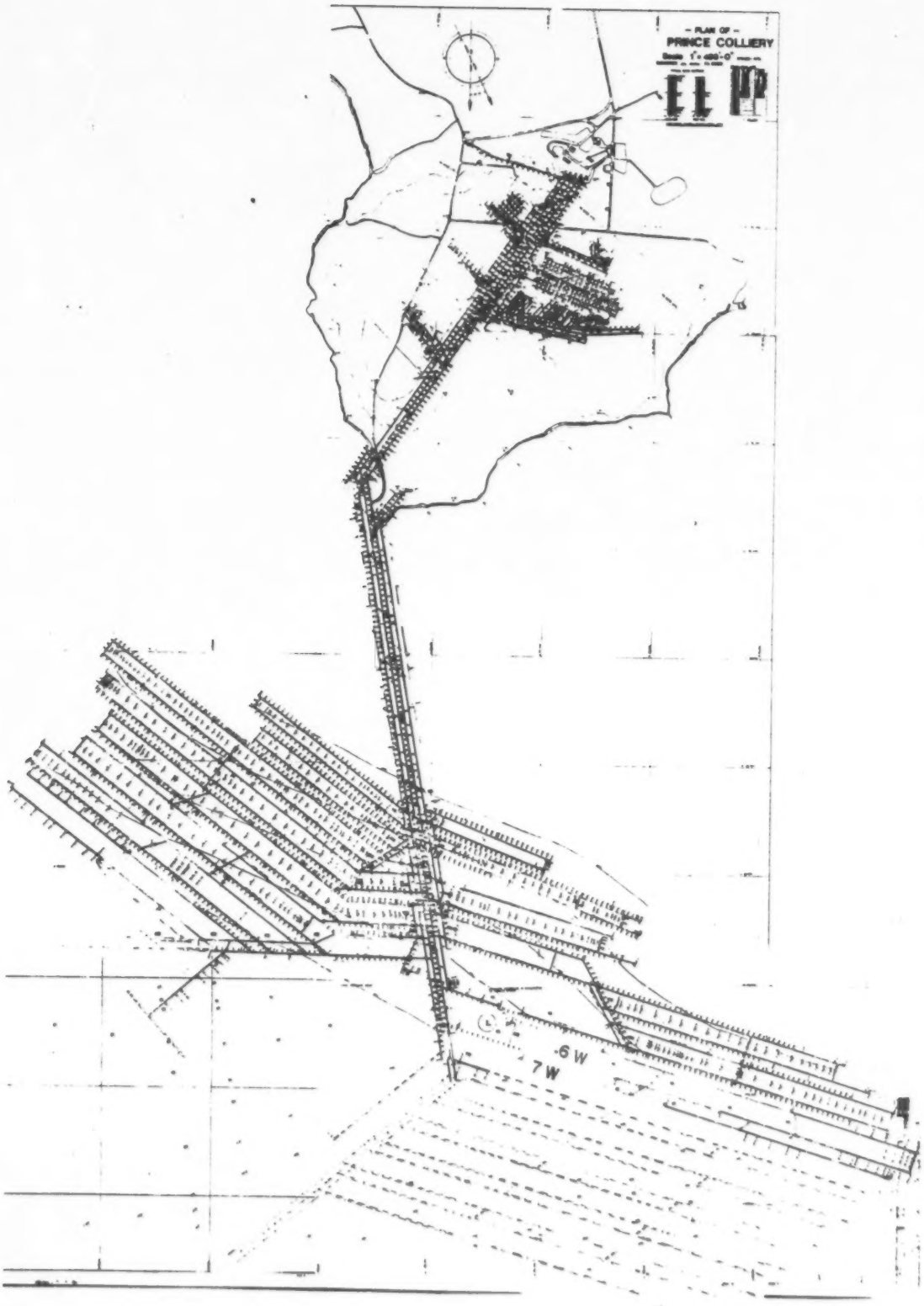


FIGURE 3-1

LOCATION OF CBDC MINES

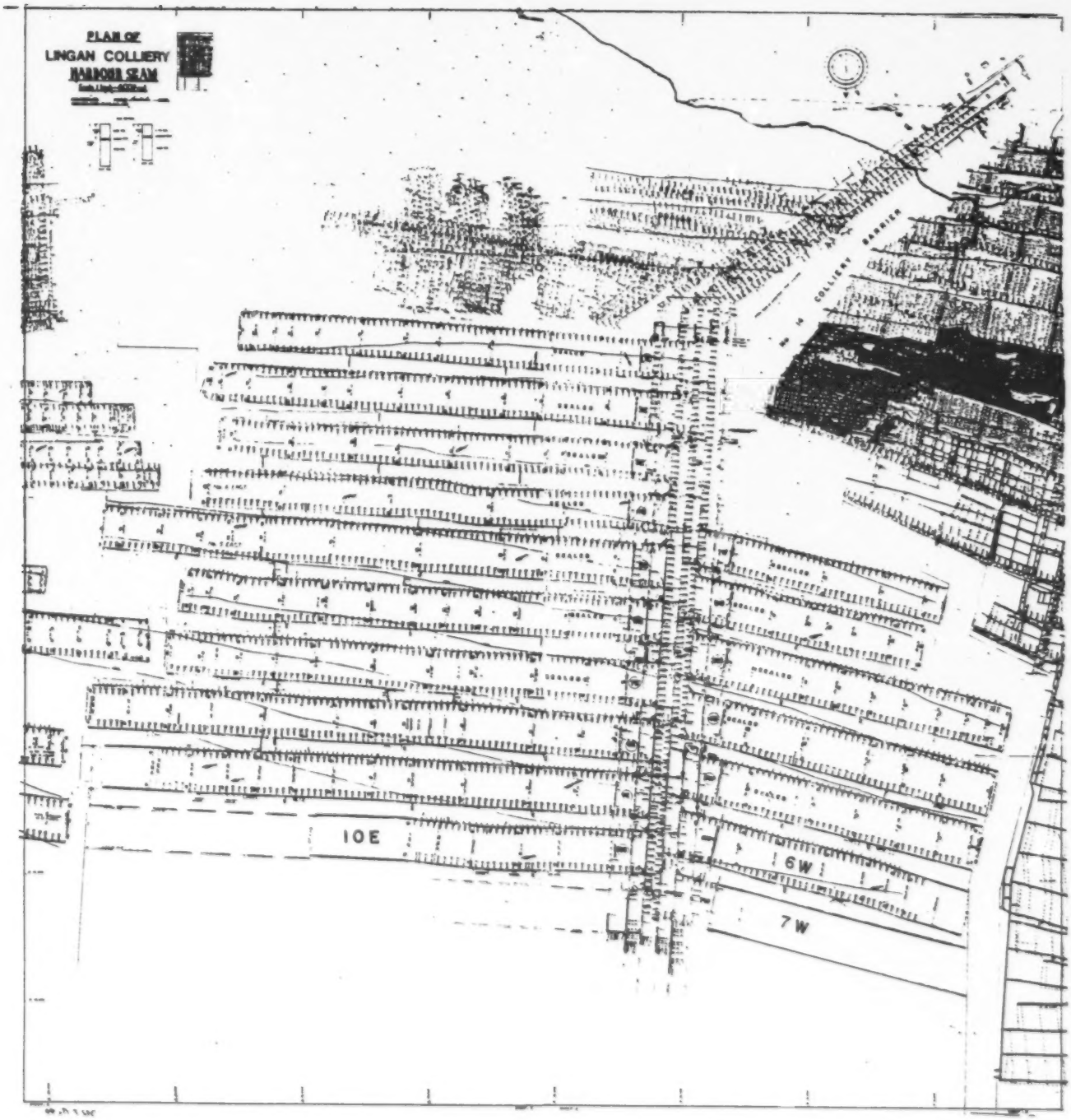
(Source: Monenco)



PRINCE MINE - PLAN

FIGURE 3-2

(Source: CBDC)

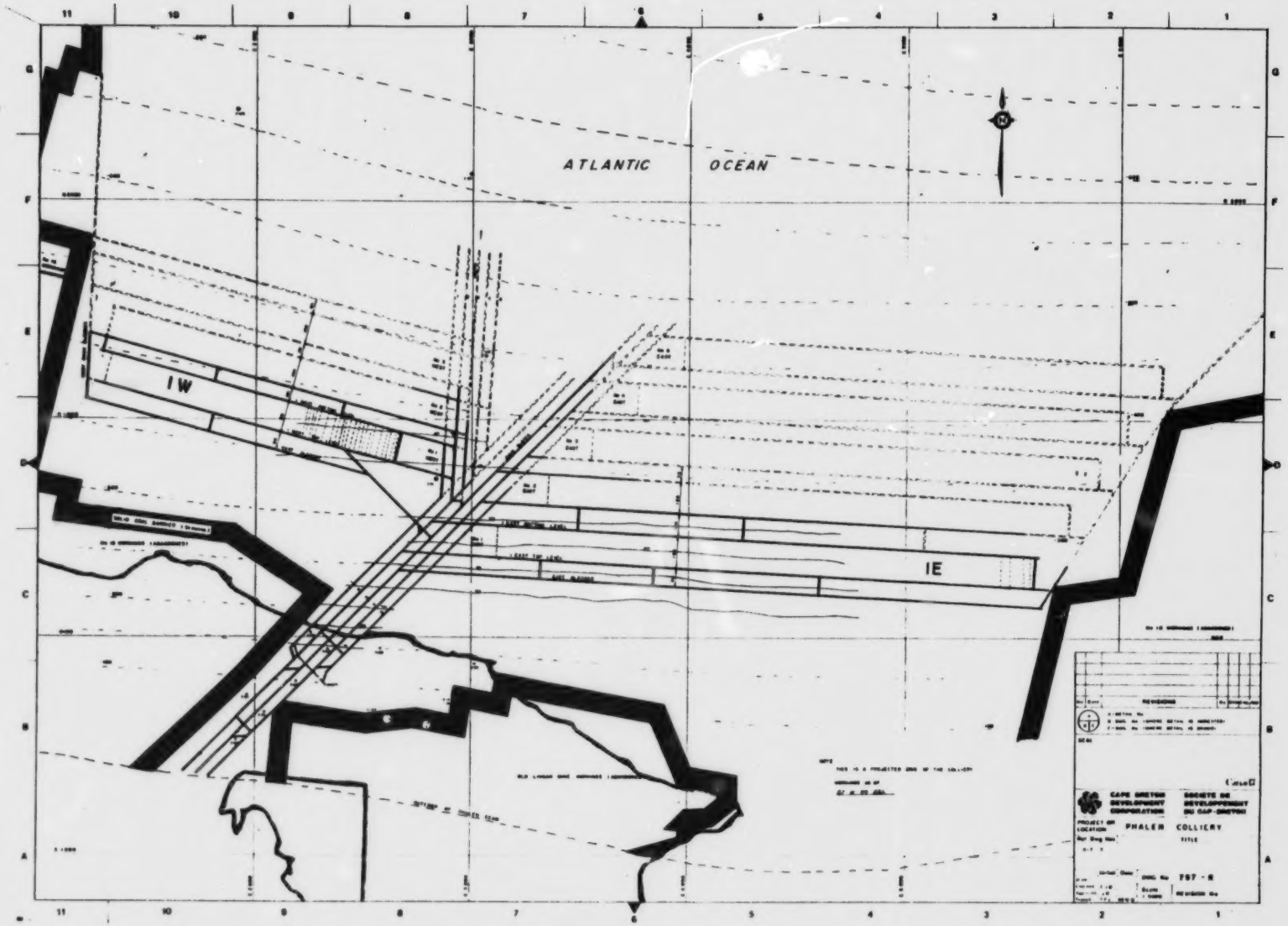


LINGAN MINE - PLAN

(Source: CBDC)

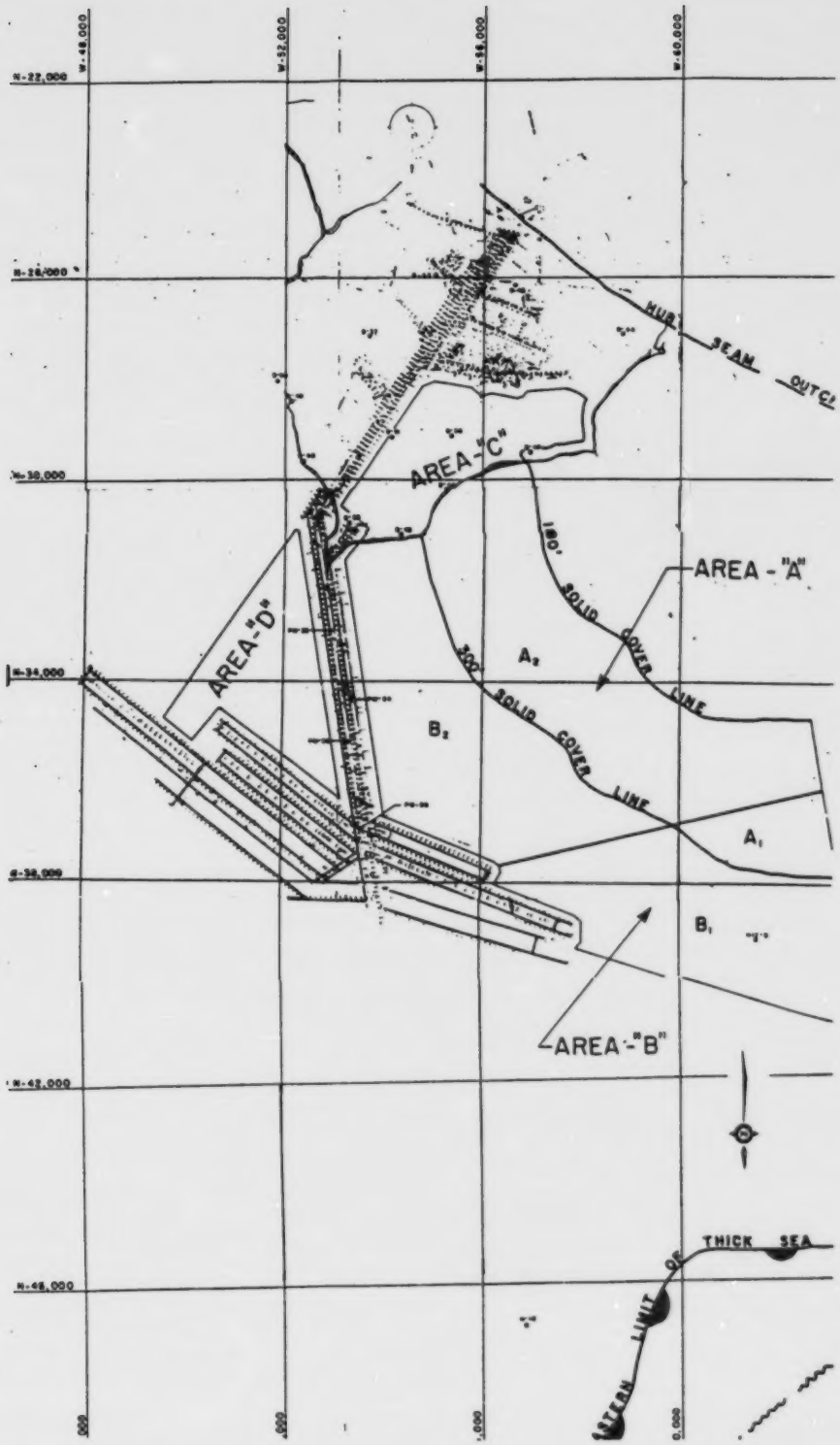
FIGURE 3 - 3

FIGURE 3-4



PHALEN MINE - PLAN

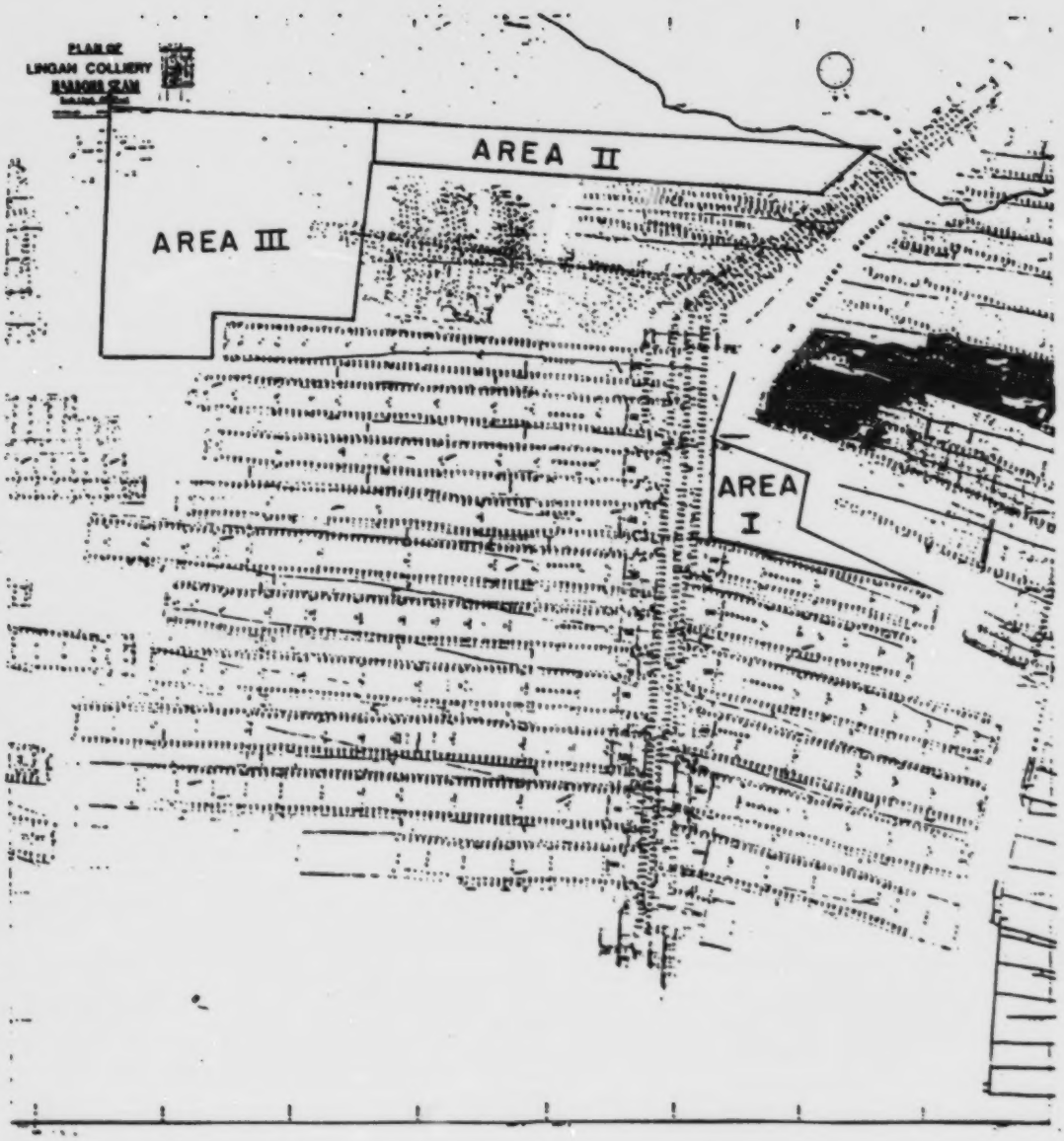
(Source: CBDC)



PRINCE MINE - POTENTIAL SITES

(Source: Monenco)

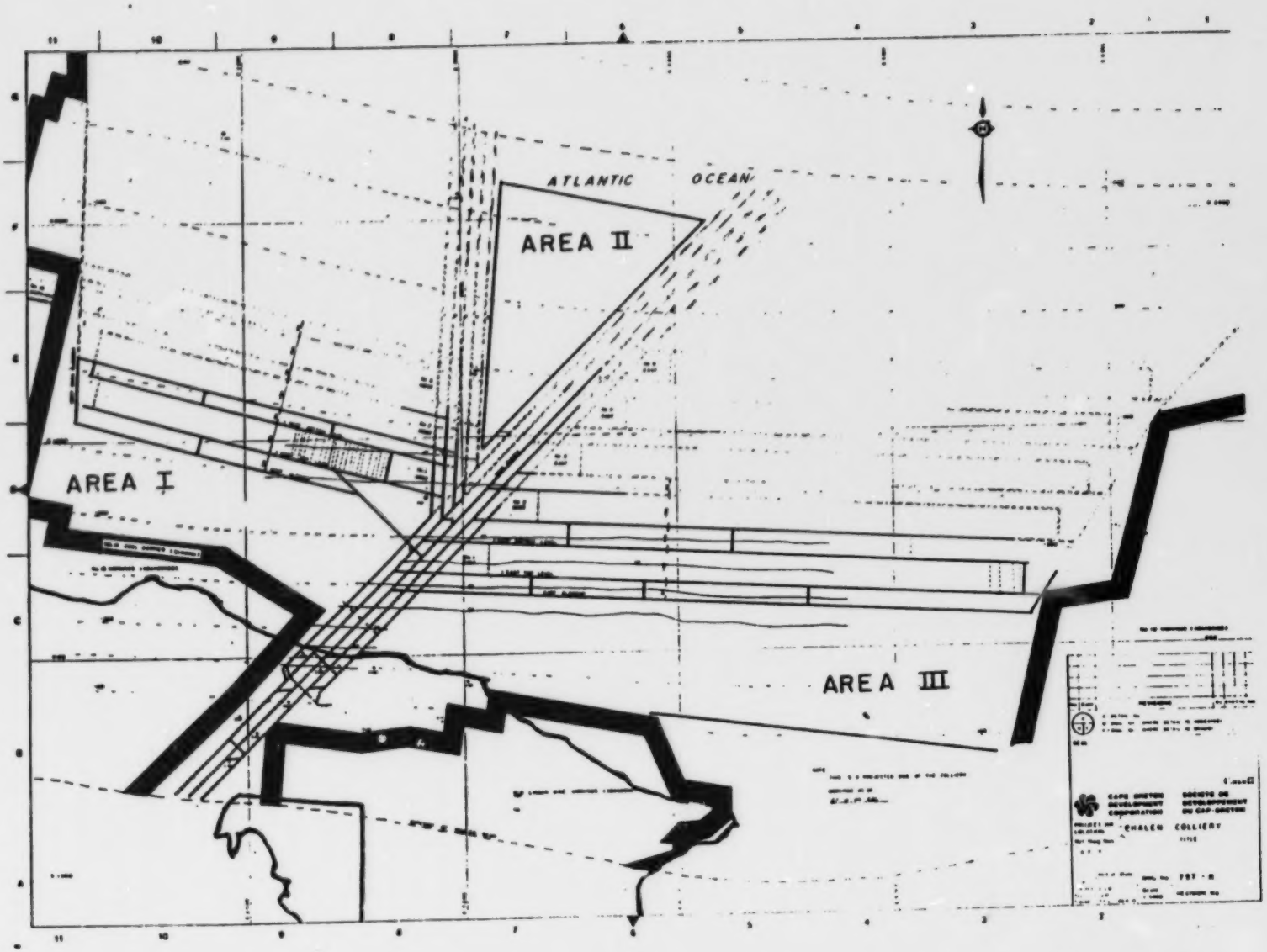
FIGURE 3-5



LINGAN MINE - POTENTIAL SITES

FIGURE 3-6

(Source: Monenco)



PHALEN MINE - POTENTIAL SITES

(Source: Monenco)

FIGURE 3-7

TABLE 3-1

6W LONGWALL RETREAT FACE - PRINCE MINE

Depth of Cover	230 m
Seam Height	2.34 m
Face Length	113 m
Panel Length	2744 m
Pillar Width	65 m
Gradient	2°-3° along face
Shearer	- Anderson Strathclyde AMBROAS DERDS. (225 kW) - Dynatrack haulage - Powered cowls - 3 start 2.0 m dia. drum with pick face flushing and parrot type picks - 0.66 m web. - Cutting speed 8 m/min. max.
AFC	- Halbach & Braun 2 x 26 mm outboard chains, 1 metre flight spacing - 105 kW in line drives at main gate and tail gate
Stage Loader	- As for AFC but with single drive and 0.5 metre flight spacing - Coal sizer on stage loader - 10 m overlap over gate conveyor
Face Supports	- Hemscheidt 2 x 320 t shields with powered forward cantilever (68) or with rigid canopy (6) - Operated on manual adjacent control - Equipped with face lighting
Roadway Supports	- 0.15 m x 0.15 m x 4.27 m long RSJ with pin jointed steel legs, lagged and strutted
Roadhead Supports	- Tail Gate - 2 - 4 leg anchor chocks with extended canopies - Main Gate - 2 - 4 leg anchor chocks with extended beam and fifth leg - Roadhead chocks normally long enough to support 2 Roadway girders with face side legs removed
Gate Conveyor	- 3 - Huwood Scout 90 kW Drives in series (approximately 900 m long each) with 15 m loop take ups. 0.92 m wide belt

TABLE 3-1 (Cont'd)

6W LONGWALL RETREAT FACE - PRINCE MINE

Ventilation	- On face - approximately 17.4 m^3/sec. - CH_4 - 0.2% to 0.4% when cutting - methane emission 0.3 m^3/t	
Power	- 1100 V - All electric control boxes, powered support power pack, transformers, etc., on rail mounted units moved back every 100 m. Hoses and cables to face carried on mono-rail.	
Face Manpower per Shift	- Shearer	2
	- AFC Rams	1
	- Face Supports	2
	- Main Gate End	4
	- Tail Gate End	3
	- Stage Loader	1
	- Consol	1
	- Mechanic	1
	- Electrician	1
	- Supervision	1
		17
Performance	- max. 2 shears/hour	(520 t)
	- max. 12 shears/shift	(3100 t)
	- Face OMS	180 t
	- Face availability	6 hours

TABLE 3-2

7W MAIN GATE DEVELOPMENT - PRINCE MINE

Depth of Cover	240 m	
Heading Height	2.34 m	
Heading Width	4.27 m	
Heading Length (max.)	2744 m	
Gradient	2° across heading	
Roadway Supports	- Hollybank Rectangular 0.15 m x 0.15 m RSJ + 2 legs (pin joints) - Lagged and strutted - Set at 0.9 m intervals	
Drivage Machine	- Dosco Dintheader - 12 m Bridge Conveyor	
Coal Clearance	- 920 mm Gate Belt - Huwood TB 80/120, 90 kW Drive with 13 m loop take up	
Materials Transport	- Clayton battery locomotive + Pikrose flat deck cars	
Ventilation	- 37.5 kW Engart fan. (forcing) - 910 mm smooth Flexiduc ducting - 4.7 m^3/s at face	
Performance	- Average 7.3 m/shift	
Manpower	Heading Machine	4
	Mechanic	1
	Electrician	1
	Materials supply	3
	Supervision	1
		10
	Manpower Limit 15	

TABLE 3-3

10E LONGWALL ADVANCING FACE - LINGAN MINE

Depth of Cover	600 m
Seam Height	1.8-2.0 m (+0.3 m following stone)
Face Length	222 m
Panel Length	2530 m
Pillar Width	60 m
Gradient	8°
Shearer	- Anderson Strathclyde DERDS. AM300 (225 kW) - Eicotrack haulage - Powered cowls - 1.2 m dia. drum with pick face flushing - 0.71 m web - Cutting speed max 8 m/min, average 4 m/min - Bretby cable handler
AFC	- Halbach & Braun twin inboard 26 mm chains, with closed bottom pans, 1 metre flight spacing - 105 kW in line drive units at main gate and tail gate
Stage Loader	- As for AFC except single drive and 0.5 metre flight spacing. Headend on monorail
Face Supports	- Hemscheidt 2 leg (360 t) shields with powered forward cantilever
Roadhead Supports	- 4 leg Dowty chocks across both gate roadways (4 in each gate)
Roadway Supports	- Tail Gate - 127 mm x 114 mm 3 piece arches plus solid wood chock on pillar side and solid wood chock plus 1.5 m solid pack on goaf side - Main Gate - arches (as TG) plus solid wood chock on pillar (low) side and solid wood chock plus 1.1 m wide pump pack on goaf side. (50% Astrocem, 50% Astrobent; 2.5:1 liquid/solids ratio, 20 min setting time.)

TABLE 3-3 (Cont'd)

10E LONGWALL ADVANCING FACE - LINGAN MINE

Tail Gate Ripping	- Drilled and fired, and loaded by Eimco 21 side discharge loader onto Python chain conveyor direct onto face AFC. Taking 2 m rock. Rock drill suitable for mounting on Eimco. Suspended from arches when not in use.	
Main Gate Ripping	- Drilled and fired, and loaded by Webster loader onto stage loader.	
Main Gate Dint	- Webster loader onto stage loader	
Materials Handling	- By endless rope haulage in TG, diesel locomotives in MG both using GMT materials flat cars, and by compressed air Becorit monorails over last 50 m in both gates	
Gate Conveyor	- 920 mm wide belt, Huwood TB 80/120 drives, 15 m loop take ups	
Power	- 1100 v with control boxes, transformers and power pack all monorail mounted	
Ventilation	- 16.5 m^3/s target quantity on face - methane emission 28-30 m^3/t (15-20 m^3/t in earlier faces) - methane drainage practiced in TG with 43 m long holes (9 m casing) at 55° inclination set at 24 m intervals. Extracting 0.17-0.21 m^3/s methane. System in operation 2 1/2 years and has vastly improved conditions on face, especially in TG - BMI monitors set at 1.25% CH_4 cut off (TG)	
Face Manpower/Shift	- Shearer	2
	- AFC/rams	2
	- Supports	2
	- AFC/stage loader	1
	- TG Ripping	4
	- TG Pack	4
	- MG Pack	5
	- MG Ripping	4
	- Stage loader	1

TABLE 3-3 (Cont'd)

10E LONGWALL ADVANCING FACE - LINGAN MINE

	- Methane Drainage	3
	- Mechanic	1
	- Electrician	1
	- Supervisor	1
		31
Performance	- Average 2 -3 shears/shift	
	- 3-8 hr shifts/day	
	- Face availability 6 hours	
	- Average shift output 1100 t	

TABLE 3-4

7W LONGWALL ADVANCING FACE - LINGAN MINE
(with Main Gate Advance Heading)

Depth of Cover	620 m
Seam Height	1.9 m
Face Length	222 m
Panel Length	1240 m
Pillar Width	60 m
Gradient	8°
Shearer	- Anderson Strathclyde AM300, DERDS (225 kW) - Eicotrack - 0.71 m web, 1.2 m dia. drum with pick face flushing
AFC	- Halbach & Braun twin inboard 26 mm chain with closed bottom pans, two in-line drives
Face Supports	- Hemscheidt 2 leg shields (142)
Roadhead Supports	- Dowty 4 leg Buttress chocks (3 in TG) - At MG, one Dowty 4 leg chock + 1 Dowty 6 leg Buttress chock + 2 Dowty 4 leg Pack hole supports with rear cantilever bars
Main Gate Roadway	- 3 piece U section yielding arches - At face end, crowns supported by 4 leg in-line sliding beam support bridging face AFC. 4 Arch legs taken out. Double wood/dirt packs built.
Tail Gate Ripping	- Drilled and fired, loaded by Atlas Copco (56 kW) loader onto short AFC to face AFC - Wooden chocks at roadsides - 2 piece arches
Main Gate Advance Heading	- Dosco Mk IIB Roadheader - Bridge conveyor - 10 m ahead of face - Set 4.9 m x 3.66 m 3 piece yielding arches - Face side above seam bolted. 2-2 m bolts every 0.6 m - Webster boom loader for clean-up at face end

TABLE 3-4 (Cont'd)

7W LONGWALL ADVANCING FACE - LINGAN MINE
(with Main Gate Advance Heading)

	- Ventilation 37 kW Engart Fan + wet dust filter and 0.76 m ducting - methane 0.25% - performance 2 arches/shift cutting horizontal floor	
Main Gate Dint	- Haus Herr Dinter loading onto stage loader	
Manpower	- as per IOE face plus, in advance heading:	
	Dosco Roadheader	3
	Webster loader	1
	Electrician	1

TABLE 3-5

1W LONGWALL RETREATING FACE - PHALEN MINE

Depth of Cover	350-400 m
Seam Height	1.8 m coal and 0.6 m shale/coal
Face Length	150 m
Panel Length	1380 m
Pillar Width	80 m (upper), 60 m (lower)
Gradient	12°
Shearer	- Anderson Strathclyde AM500 DERDS - Powered cowls - Max. speed 8 m/min - limited to 4 m/min - Drum diameter 1.5 m with pick face flushing - 0.7 m web - Eicotrack haulage
AFC	- Dowty twin inboard 26 mm chain AFC with closed bottom pans. Two drive units, in line with coal sizer on AFC at MG end with separate drive. AFC TG Drive has short drive frame - AFC side discharge onto Dowty beam type stage loader (0.91 m wide)
Stage Loader	- 15 m overlap
Gate Conveyor	- 1.07 m wide, FSW drive unit (90 kW)
Face Supports	- Dowty 2 x 550 t shields wth Dowval electronic control and face lighting
Tail Gate Support	- Roadway driven by Dosco Mk 2B and supported on 3 piece arches - Powered support in roadway comprised 2 - 4 leg Buttress chocks with extended canopies with one single offset leg over the face AFC. Support chocked on top to suit arch profile
Main Gate Support	- Roadway support - trapezoidal section - Powered support in roadway comprises 2 - 550t 2 leg shields with rigid canopies extended to catch roof girders at face ends

TABLE 3-5 (Cont'd)

1W LONGWALL RETREATING FACE - PHALEN MINE

Power	- 1100 v with all control boxes, transformers and power packs (3) suspended on monorail	
Materials Handling	- Endless rope haulages with Pikrose cars in 1W (Scharf monorail intended for 2W)	
Ventilation	- 28 m^3/sec with 0.3% CH_4 in MG and 0.6% in TG	
Manpower	- Shearer	2
	- AFC Rams	1
	- Face Supports	1
	- Tail Gate	2
	- Main Gate	2
	- Console	1
	- Mechanic	1
	- Electrician	1
	- Supervisor	1
		12
Performance	- 3-4 strips normally - Face production limited by outbye conveyors until cable belt commissioned - Average day (2 shifts) 2000 t -1W Face - Best day (3 shifts) 7000 t - 1E Face - Best week 30000 t - 1E Face	

TABLE 3-6

2W MAIN GATE DEVELOPMENT DRIVAGE - PHALEN MINE

Depth of Cover	450 m	
Roadway Height	2.8 m	
Roadway Width	4.3 m	
Roadway Length	1650 m	
Gradient	12° across heading	
Roadway Shape	Inclined rectangular	
Road Support	- Hollybank rectangular 0.15 m x 0.15 m RSJ + 2 legs (pin joint) - lagged and strutted - set at 0.9 m intervals	
Drivage Machine	- Westfalia VME Roadheader - Curved gathering and discharge conveyor - 120 kW cutting head with external sprays - Canopy over operator - Girder setting device	
Coal Clearance	- 30 m long bridge conveyor - 1.07 m wide gate conveyor	
Materials Transport	- Scharf monorail with endless rope drive	
Ventilation	- 90 kW Engart fan forcing 4.7 m^3/s with 37.5 kW auxiliary exhausting system with spiral ducting	
Manpower	- VME	5
	- Conveyor	1
	- Materials	2
	- Monorail	1
	- Supervisor	1
		10
	- Electrician and mechanic on call - Manpower Limit 15	
Performance	- Best shift - 13 m - Average shift - 7.2 m - Average day - 20 m - Average week - 100 m	

Note: Dosco Mk IIB averaged 4-5 m/shift in coal and 1-2 m/shift in harder rock
Dintheader averaged 100 m/week

PART 4

SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

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4.1 SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS SESLR)

4.1.1 Definitions and Usage

Because of the varying usage of the words 'single entry' in different parts of the world, it is necessary to clearly define the context in which the words are used in this report.

In European and Canadian coal mines, the standard layout for a conventional longwall face is with a roadway or gate road at each end of the face [Figure 4-1(a)].

In U.S.A., S. Africa and Australia, the standard layout requires multiple entry roadways - usually two or three at each end of the face [Figure 4-1(b)].

However, where, in these countries, longwall faces are being worked with a single roadway to each end of the face (as per European layouts), the system is described as being a 'single entry' system. This is not the system referred to in this report, which defines a 'single entry' longwall system as being a longwall face serviced by only one roadway as illustrated in Figure 4-1(c).

The Single Entry Short Longwall Retreating System has been used, in one form or another, since 1980 for the mining of isolated or broken areas of coal, for mining by partial extraction where subsidence has to be eliminated or minimized, and as a major production system.

Some 17 mines in U.K., West Germany, Australia and Morocco have used the system. Currently there are four mines in the U.K., one in West Germany, one in Morocco and one in Australia operating the system, whilst a further five additional mines (three in U.K., one in FRG, one in Hungary) are known to be considering the system.

The Wistow mine in the U.K. has now worked more than 15 such faces; the Stolzenbach mine in W. Germany is now on its 22nd face, and both the Sherwood and Mansfield mines in the U.K. expect to work many faces as they are used to mine coal by partial extraction under urban centres.

Table 4-1 summarizes the main details of installations at the 17 mines.

The SESLR system has been developed with a basic format and a number of layout alternatives and equipment variations. These, as briefly described in the following sections, are:

- o Basic System - Total Auxiliary Ventilation
- o Alternative #1 - Single Through Roadway with Auxiliary Face Ventilation
- o Alternative #2 - Single Through Roadway with Face Return behind Supports through Waste
- o Variant #1 - Single Machine for Roadway Development and Mining

Of the 17 mines which have worked the SESLR system, only three have not used the Basic System. Alternative #1 was proposed for the Rheinland Mine (FRG). Alternative #2 was specified for the Gretley Mine (Australia) which commences operations in June 1988.

Variant #1, as far as can be determined has not yet been applied.

4.1.2 Basic Layout (Total Auxiliary Ventilation)

The basic SESLR system comprises a single roadway driven from main or district roadways to a predetermined distance, with a short longwall face developed off this single roadway. Figure 4-2 shows a typical layout. The length of the single roadway is usually dictated by ventilation considerations and the size of the area to be worked. The single 'blind' face is then retreated back to the main or district roadway with the ventilation of the gate roadway and face being maintained by auxiliary ventilation systems.

The roadway is driven using conventional continuous miners, roadheaders or similar machines, which are also used to develop the face line.

The face is then equipped with powered supports, chain conveyor, shearer, ventilation ducting incorporated into the conveyor furnishings, and monitoring and communications systems.

A stage loader and belt conveyor are located in the roadway together with special powered supports at the face/roadhead interface. A control station is located on the stage loader incorporating the monitoring and communications reporting units.

In a number of recent installations, the face AFC and stage loader have been replaced by a single curved chain conveyor.

Ventilation is usually forcing using fans located adjacent to the face and outbye the single entry.

Materials transportation is by either locomotive or rope haulage using rail bed materials cars or by free steered vehicles, (FSV).

Most systems are very similar, 30-50 m face length and up to 1000 m panel length, but their safe and efficient operation is very dependent on the considerable amount of planning and attention to detail that went into their design, establishment and operation.

Typical of a system which developed out of a crisis need and had to utilize existing conventional longwall equipment, is the current installation at Wistow mine (U.K.), whilst the installation at Gretley mine in NSW Australia is typical of a system which was custom designed. These are described in detail in Sections 4.3.1 and 4.3.6 respectively.

The most critical and important aspects of the Single Entry system are dealt with in detail in Section 4.2.

4.1.3 Alternative #1 - Single Through Roadway with Auxiliary Face Ventilation

In this alternative, the short face is still maintained at right angles to the single roadway and is ventilated using auxiliary systems. However, the single roadway is no longer a 'blind' end, but is maintained throughout its length. It is connected to intake and return roadways so that mainstream through ventilation is maintained. A solid pack (pump pack) is placed at the roadside immediately behind the face powered supports to ensure that the roadway behind the face is kept in usablecondition. Additional support at the roadway/face interface is necessary through the use of powered supports and/or rock bolts. A typical layout is shown in Figure-4-3. A typical example of this alternative is given in Section 4.5.1 which describes the system proposed for use at the Rheinland Mine in West Germany.

4.1.4 Alternative #2 - Single Through Roadway with Face Return Behind Powered Supports

In this alternative, the short blind end face is maintained at right angles to a single through roadway, or off one of a pair of development headings forming a main ventilation circuit. There are, however, no auxiliary ventilation systems used, as the powered supports along the face and across the roadway are sealed so as to prevent leakage through them. The ventilation current thus flows up the roadway, is deflected along the face, and passes by the last support in the blind end and returns behind the supports to the roadway, and returns out of the mine. This alternative, which relies on maintaining an airway through the waste area, is illustrated in Figure 4-4, and described in Section 4.3.6 which

reports on the Gretley installation in Australia where this alternative is being tried.

4.1.5 Variation #1 - Same Machine Used to Develop Roadway and Mine Face

This is a variation on the basic system whereby the same machine is used to drive the roadway, open up the face line and mine back the retreating face.

These are special purpose machines of the types made by Eickhoff (ESA 60, ESA 150, ESA 300); Westfalia (VME and derivatives) and DOSCO (In-Seam Miner - ISM 2000, ISM 3000).

These machines, and their comparable advantages and disadvantages as applied to the SESLR system, are discussed in more detail in Section 4.6. Descriptions of the installations at Stolzenbach (FRG) and OCF (Morocco) and the proposed installation at Norgrad (Hungary) are given in Sections 4.3.5, 4.3.7 and 4.5 respectively.

4.2 CRITICAL ASPECTS OF THE SESLR SYSTEM

The application of the Single Entry system has to be approached with caution since its use adds a considerable element of risk when compared to either a single drivage, or a conventional two entry longwall face.

There are several aspects of the SESLR system which are critical to the safe and successful operation of a single entry face. These include:

- Ventilation
- Support
- Methane and Dust Control
- Monitoring
- Communications
- Access
- Frictional Ignition Control
- Rates of Retreat and Materials Handling
- Manning Levels

These are discussed in more detail below.

4.2.1 Ventilation

This is the most critical aspect due to the need to ensure control of methane emissions from the waste area with the lower ventilation

quantities that result from the need to use auxiliary ventilation systems which result in considerably lower pressure gradients than normally apply to the conventional two gate longwall face.

There is a particular need to ensure continuity of ventilation at all times, and to design the ventilation system to minimize the risk of having to carry out a degassing operation.

If it is accepted that a forcing system is better than an exhausting system due to lower ducting resistance and easier handling of the ventilation ducting, there are three basic auxiliary ventilation systems using primary and secondary auxiliary fans which can be considered.

Any ventilation system has to be capable of dealing safely with methane, dust and temperature.

.1 Single Ducting with Primary and Secondary Fans (Figure 4-5)

In this system, a primary forcing fan is located in the main district intake roadway, outbye the single entry roadway. Air is forced through ducting (lay flat) to a secondary fan (in series) mounted on or adjacent to the stage loader. This secondary fan boosts the air through flexible ducting laid in a special vent duct forming part of the furnishings to the face conveyor (Figure 4-6). Air is thus discharged at the end of the conveyor in the blind end of the face, and returns through the face and the roadway.

The major advantages of this system are:

- Face ventilation can be maintained or interruptions minimized, whilst the ducting is shortened back, by keeping the secondary fan running.
- Provides a greater volume of air to the face and in the roadway than with only a primary fan.
- Some ventilation can be maintained to the face even if there is no power to the secondary fan.
- Requires only one duct in the roadway.

The major disadvantages are:

- Additional noise from the secondary fan located in the face area.
- Requires an additional power supply for the secondary fan, independent of the power supply to the face equipment.

Using 900 mm ducting, with a 90 kW primary fan and a 37 kW secondary fan, and assuming a roadway length of 1000 m and a face length of 40 m, ventilation quantities on the face should be of the order of 6.0 m^3/s.

.2 Single Duct Primary System plus Separate Secondary Recirculation System at Face (Figure 4-7)

In this arrangement, the primary fan forces air through lay flat ducting in the roadway to discharge air in the roadway to the rear of the ribside roadhead support. The secondary fan, mounted on the stage loader, forces air from the roadway through the face vent duct to the blind end, the systems overlapping in the region of the stage loader. A certain amount of air is thus allowed to recirculate through the face. It has been proved, both in theory, and in practice at the over 50 approved operating systems in the U.K. coal mines, that provided the total quantity of air entering the ventilation system is sufficient to dilute the emitted methane, methane build up does not occur in the recirculation or secondary system.

The major advantages of this system are:

- Ventilation to face not interrupted when shortening back.
- Through use of automatic change over box in the event of power failure to the secondary fan, some ventilation to the face can be maintained (Figure 4-8).
- Potential to increase air flow on face and in vicinity of face.

The major disadvantages are:

- Additional noise source from secondary fan in the face area.
- The use of recirculation may require an exemption from the Mines Inspectorate.
- Separate power supply to secondary fan required.

Typical air quantities using a 90 kW primary fan with 900 mm ducting and a 37 kW secondary fan for a 40 m face and a 1000 m long roadway would be the order of:

Face 6.0 m^3/s
Primary Fan 8.0 m^3/s

The air flow in the overlap or recirculation zone would be closer to 14 m^3/s

.3 Twin Parallel Forcing Ducts with Primary Fans (Figure 4-9)

In this case, two primary fans are located in the main or district intake roadway. One fan forces air through ducting to discharge air at the rear of the roadside powered support. The second fan forces air through its own ducting and through the face ducting to discharge air at the blind end of the face. Thus the working area is served by two separate auxiliary systems.

The major advantages are:

- Greater airflow in the roadway.
- All ventilation power, including face ventilation, located in main intake.
- No fan at the face thus less noise.

The disadvantages are:

- Ventilation to face disrupted when ducting shortened back.
- Two ducts to handle in the gate.
- Airflow on face reduced due to increased resistance.
- Greater leakage in face ventilation system since maximum resistance is in face ducting.

The quantities likely to be delivered to a 40 m face, 1000 m inbye using 90 kW fans and 900 mm ducting are:

Face 4.0 m^3/s
Gate 12.0 m^3/s (8.0 from gate duct and 4.0 from face)

There are, of course, several variations on these items such as a single primary fan and ducting, or more use of twin ducts. However, it is noted that whilst the most common system in use is the Single Ducting with Primary and Secondary Fans in series (Figure 4-5), more consideration is being given to the Recirculation system.

.4 Continuity of Ventilation

The ventilation system used should be designed to provide continuity of ventilation. In the case where secondary fans are

used and power is lost to those fans, the provision of automatic change over boxes should suffice to maintain ventilation to the face.

In the case of failure of the primary fan, the provision of a standby primary fan with automatic changeover doors should provide an acceptable alternative.

In the event of a complete failure of power to the mine or district, consideration must be given in the design to alternative ventilation power sources such as the use of:

- o pit pressure through doors
- o If compressed air is available, the use of M120 Venturis in the ducting.

Emergency ventilation should be sufficient to keep methane in the general body below 2%.

System designs should also, where possible, be such that single entry workings retreat to the dip to ensure better gas control.

.5 Degassing

One of the factors which has to be considered in the design of the ventilation system is the ability to degas a single entry face district following a complete failure of all ventilation systems for that district. The removal of a potential solid plug of methane has severe risks, and involves a carefully prepared plan which takes into account:

- o location of electrical equipment
- o integrity of all electrical equipment over which gas may pass
- o safe route for gas to exhaust from the mine

4.2.2 Support

The area at the junction of the face and the roadway is the most critical area, being the region of highest risk requiring interaction between the roadway supports and the face powered supports.

Roadway supports should be of steel with positive attachment between beam and legs. These should also permit easy removal of the face side leg as the face line is retreated. Supports should be effectively strutted and meshed or lagged.

In poorer ground, the use of additional support such as rock bolts should be considered.

In strong roof conditions, the use of an wider spaced steel set with intermediate rock bolt support, or even the sole use of rock bolts, straps and mesh may also be permissible.

Face support should utilize the modern powered support which provides excellent security for the face crew. These powered supports should also continue across the roadway (where the roof is flat). If an arch roadway is being used, then special powered supports should be installed in the roadway with additional rock bolting at the face entry shoulder as required. Figure 4-10 (a) and (b) gives typical layouts.

The roadway powered support should consist of a minimum of two but preferably three units. Each unit should be long enough to provide effective support to all the beams which have had their face side legs removed.

Where the coal is soft or likely to slough off, the powered support at the blind end of the face may have to be fitted with side canopies to support the cusp roof and sides.

The movement of all supports must be governed by the "Managers Support Rules," and in situations where the roof strata has deteriorated, all men should be withdrawn to the outbye side whilst the supports in that area are advanced. Many mines operating the single entry system reguire all men to be outbye any support being advanced.

The power pack for the face and roadhead supports should, ideally be located in the main airstream outbye the single entry road. Modern piping and hosing now make such locations perfectly feasible. This has the advantage of removing a heat source, the requirement of power for the pump and its standby and the need to transport the hydraulic fluid into the single entry. Care does, however, have to be taken when the range is shortened off to maintain clean connections.

The system of control for the operation of the supports should be of the electronic type, since these are the only systems which will enable the support cycle to be fast enough to maintain effective and immediate support to the newly exposed roof behind the shearer.

4.2.3 Methane Drainage

Where methane emission rates are such that gas concentrations on single entry faces and roadways cannot be controlled within the

specified limits, some form of methane drainage may have to be applied, or a limit set to the production level achieved.

Potential methane drainage systems include:

1. A pipe left in the abandoned single entry roadway and connected to a methane extraction range with regular stoppings placed in the abandoned roadway. This pipe may have to be shortened back or sections isolated as the face retreats. This method has been tried but has not been very successful to date in the U.K.

2. Connection of the waste to another roadway near the face start-line, or adjacent development, and the use of methane extraction range. This is effective only as long as there is a connection maintained through the waste.

3. Conventional methane drainage through holes drilled over the waste from an adjacent roadway. This could be done from either the single entry roadway for the next face (which would require long and accurate drilling or, as shown in Figure 4-11, driving an extra wide (16 m or 27 m) development heading as a mini advancing face and forming a monolithic pack/s in the centre to create a twin or three entry roadway system. The face side roadway would be abandoned with methane drainage being carried out from the adjacent 'roadway'.

4. Some system attached to the rear of the face and roadhead powered supports which would retreat with them and which would be connected to a methane extraction system.

4.2.4 Dust Control

Since generally, the same equipment is used to cut the coal on the single entry face as the conventional longwall face, and at probably the same speed, the dust make is liable to be very similar. However, since the ventilation quantities on the face are lower, dust concentrations could be higher. The recent introduction of the rotating air circulation (RAC) extraction drum which can be used on drums greater than 1.5 m diameter, has greatly improved dust control. The drum contains a number (6-12) of 100 mm tubes which extract air and dust from the cutting and face side of the drum. Water consumption is typically 1 litre/sec at 10 Mpa pressure. The use of pick face flushing should be a must and back face flushing also used if required.

4.2.5 Monitoring

It is essential that a comprehensive environmental monitoring system be incorporated into the design of a single entry system. Information collected by the system, together with any warnings or alarms should be displayed at the control centre on the stage loader, at the outbye end of the roadway and preferably also at the surface control centre.

Whilst the individual monitoring requirements will vary from site to site and on the ventilation system selected, the following should be included as a minimum.

- Methane measuring transducers (BM3 or BM1 type) located at the blind end of the face, at the waste edge in the face (to identify waste flushing) and at the gate/face interface. These provide continuous readings of % CH_4 to the control centres and are usually set to alarm at 0.8% CH_4 and to cut off power at 1.25% with manual reset (Figure 4-12).

- Continuous measurement of air velocity at the exit of the face ventilation duct (BA5 or TX130) usually set to alarm at a predetermined minimum airflow.

- Automatic firedamp detectors should be carried by the face crew, with a minimum of two units between the stage loader and the blind end of the face.

- Use of hand held MSA type methanometers.

- Monitoring of carbon monoxide in the general body in the roadway, especially where there is liability to spontaneous combustion. In the latter case, monitoring should also cover products of combustion.

- All auxiliary fans should be continuously monitored for vibration, indication of fan running and availability of power.

- Gate belt conveyor protection should include belt slip, torn belt, belt tension, chute blockage.

- Smoke detectors located at the outbye end of the roadway and at the inlet to each fan.

- Infrared heat detecting devices to monitor for hot spots (conveyor idlers, heatings, etc.)

In addition to the above monitoring, power should be interlocked to the alarm systems, but should be so designed as to maintain power for as long as is practical and safe to the ventilation system. Thus, the CH_4 transducers on the face should only cut off the power to the shearer and face conveyor (at 1.25%) whereas an alarm on the CH_4 transducers at the roadway/face junction should cut off the power to the heading.

4.2.6 Communications

A telephone/tannoy system throughout the district between the entrance to the roadway and the blind end of the face is essential. Communication stations should be placed at regular intervals along the gate road (say every 100 m), at the stage loader control station and at the regular intervals along the face (say 5 m) and at the blind end.

The use of the mine radio speech system through a leaky feed cable is essential where locomotives or FSV vehicles are used for materials haulage.

4.2.7 Access

By definition, a single entry system has only one exit, so that the hazards due to men working in an active mining environment (rather than a roadway drivage) from falls of ground, methane and fire are much greater.

Even greater care thus has to be taken in the design of the system, keeping equipment as simple as possible, keeping as much as possible in the main district roadways, protecting vital communications and power links, maintaining clear access, and watching for any deterioration in ground conditions or support standards and taking remedial action at an early stage.

It is interesting to note that the West German mines regulations do not allow any work to be carried out in an active mining area unless there are two exits. No exemptions has been given to this regulation, thus the proposed use of the single entry system at the Rheinland mine had to be designed to layout the face off a through roadway (Alternative #1) but also required the inclusion of a steel escape duct running the length of the face through the supports with access doors at regular intervals (Figure 4-13 and Section 4.5.1).

Extra training of workmen and officials is essential to ensure that they all fully understand the communications and monitoring systems; the method of working and the emergency procedures.

4.2.8 Frictional Ignition Risk

In any consideration of the use of the single entry system, it is vital that an assessment is made of the risk of ignitions arising through the cutting tools striking rocks which could give rise to incendive sparks. This is especially critical since methane concentrations on single entry faces are liable to be higher than on conventional faces due to reduced ventilation quantities. The use of the dust control measures described in Section 4.2.4 (RAC drum, pick face and back face flushing) should provide the proper measure of control of this risk.

In general, at least 0.04 litres/sec of water should be provided behind each pick to effectively quench any sparks. Consideration should also be given to interlocking the power to the shearer with water pressure and supply.

The RAC drum, by drawing intake air over the top of the drum, down the face side and through the drum to discharge back into the face air stream, effectively dilutes any methane given off at the cutting interface. There are over 100 of these drums in use in the UK, and they have effectively shown that when operating at their normal duty (air flow 1.5 m^3/s through the drum) a methane emission rate of up to 12 litres/sec at the drum can be safely diluted, even with 0.2% methane in the intake air.

4.2.9 Rates of Retreat and Materials Handling

Unless limited by such factors as gas emission, cutting rates on the short faces are unlikely to be much different than those achieved with the same machines on conventional longwall faces. In fact, because control and supervision are easier and roof conditions generally better, higher rates are often achieved.

The result is that faces are retreating at rates up to 180 metres in a week. This is six to seven times faster than the best conventional faces and poses new problems on the ability to shorten back all services (pipes, cables, track, conveyor) and to remove the released materials and equipment as quickly as possible. Ideally these would be immediately transhipped into the development heading for the next face which must travel at, at least the same rate.

The most important items are the shortening of the ventilation systems and the movement of the stage loader and belt conveyor.

For the ventilation system, where separate ducting is used for each fan, this is purely a matter of removing a length of ducting, however, where a primary and secondary fan are in series, some means

of gradually storing a length of ducting, until the system has retreated a duct length, is required. This usually takes the form of a rocket tube on the inlet to the secondary fan. However, as discussed in Section 4.2.1, this involves interruption to the face ventilation.

The movement of the AFC, stage loader (or curved conveyor) and gate belt is best achieved if the relationship between the different units is as follows:

1. AFC and tail end of stage loader are made as a fixed unit, i.e. constant discharge relationship.

2. Stage loader is of fixed length carrying secondary fans, electrical panels, control and communication station, and coal sizer (if used).

3. A rigid tail end to gate conveyor with the stage loader discharge at fixed point, though capable of articulation. The tail end is located in the roadway by four side staking rams operated from the powered support hydraulic supply.

4. Automatic belt storage and belt reel station at gate conveyor drive with up to 100 m storage.

When the face AFC is moved, the roadhead supports advance the drive head and the stage loader (or the complete curved conveyor) and the tail end of the gate conveyor. As the tail end moves, belt tension is reduced and belting is automatically taken into the loop take-up storage. On completion of the move, the belt automatically returns to the preset running tension, and the tail end is realigned and staked by the stage loader operator.

4.2.10 Manning Levels

The normal limit to the number of men allowed in a single entry roadway is established by regulations. In both the UK and in Nova Scotia, the limit is 9 men.

In the single entry systems in use in the UK, whilst most have an exemption from the Mines Inspectorate to raise the limit to 12, production crews are limited by the mine to between 5 and 7 men (shearer, supports, rams, roadhead, stage loader and supervisor). Electricians and mechanics are on call. The 12 man limit permits management and safety officials and materials transport crews to enter the district without having to withdraw workmen from the face.

The 12 man limit has also been found to be necessary during the installation and salvage operations.

In granting exemptions in the UK, the Mines Inspectorate has laid down certain conditions. These usually include:

- Additional personnel from stated categories only.
  - management staff
  - safety services
  - examinations
- Stipulated minimum ventilation quantities.
- Stipulated monitoring.
  - CH_4 monitor - blind end and loader gate end
  - Air velocity - face duct exit
  - CO monitor - district
  - Smoke detection - district
  - Vibration - all fans
  - Automatic firedamp detectors - on face
- Telephone/tannoy system throughout district to blind end

4.3 CURRENT USERS

As at the writing of this report, there are seven mines known to be working the Single Entry Short Longwall Retreating System in its basic or alternative forms. These are:

- Wistow Mine - UK
- Sherwood Mine - UK
- Mansfield Mine - UK
- Allerton Bywater Mine - UK
- Stolzenbach Mine - FRG
- Gretley Mine - Australia
- OCP Phosphate Mine - Morocco

Brief details of the single entry installations at these mines (where available) are given in the section following. It should be noted that where cost data is given, the following conversion rates have been used £1 = $2.30 Cdn; 1 DM = $0.80 Cdn.

4.3.1 Wistow Mine, Selby Complex - British Coal

The Wistow Mine of British Coal is the first of the five producing mines in the Selby Complex to enter production in the 2.4 m thick Barnsley Bed seam (Figure 4-14). It was planned that all the output would be won from conventional retreat faces with face

lengths determined from the experiences gained at the closed Peckfield Mine which had mined towards the new area.

The first longwall retreating face (138 m long) commenced in August 1983 (Figure 4-15) and achieved weekly outputs of over 30,000 ROM tonnes before severe weighting and inrushes of water from the heavily watered Lower Magnesium Limestone (Permian) some 80 m above the workings stopped production.

It was assumed that the extraction of the full height of the Barnsley Bed Seam and the rapid rate of retreat had placed too great a strain on the base of the Permian strata, and that the powered support design with an extended back canopy had also contributed to the severe weighting which occurred.

The replacement face was designed to take these factors into account and was equipped to extract a lower section of 2.2 metres with a re-designed 4 x 450t chock shield with a reduced canopy length. Rates of retreat were limited until the over square position was reached, and then gradually increased to target those reached by the first face, but before these rates were achieved, heavy weighting and water incursion was again encountered, forcing the realization that future workings of this type were untenable in this area. This decision had serious financial implications for the mine which had been planned to extract the majority of its projected tonnage of 2 million tonnes per year from this SW side which had been developed and equipped accordingly. As it was some time before other sections could be brought into production other methods of extraction were considered. It had been apparent during the working of the first two faces that, when weighting occurred, the 45 metres of face next to the gate roads had been relatively unaffected, and it was decided to retreat the rise side gate of the second face using 45 metres of face-line as a single entry unit. This trial utilizing the insitu equipment was of short duration, and was quickly abandoned because of high water makes from the goaf associated with the previous longwall working.

It was decided to proceed with the single entry system, and the first 2 single entry units were designed with a 45 metre total face length to extract a section of 2.44 metres, and give a maximum strain to the base of the Permian of 12.9 mm per metre. The equipment was purpose designed with 4 x 650t chock shields and specially fabricated AFC furnishings to incorporate 600 mm flexible ventilation ducting. No problems were encountered with water or weightings and the faces completed their planned life span. The next pair of faces were similarly designed and equipped, but these met water problems which were not accompanied by the usual weighting. This occasioned a redesign in mid term, and the faces were shortened to 39 metres with a reduced working section of 2.11 metres to limit the strain on the base of the Permian to no more

than 10mm per metre. At this point it was accepted that this side of the mine should be considered within the constraints of undersea working, and any future extraction would be planned to limit strains to be within 10mm per metre.

This single entry system has now been successfully operated for the last two years with face lengths and pillar widths determined by the NCB rules for "Working under the Sea."

Wistow has mined 16 single entry panels and at the date of the visit, A14's face was completing the mining of a 1000 m long panel with a 35 m long face in a six week period (Figure 4-15).

Summary details of A14 single entry face and the adjacent A15 development drivage are given in Tables 4-2 and 4-3 respectively. Figures 4-16, 4-17, 4-18, 4-19 and 4-20 show respectively the general arrangement of the face, the cutting sequence, face section, main gate arrangement and the main gate support system.

In addition to the information given in the tables, the following comments are relevant.

- The mine is not liable to spontaneous combustion, and the floor is a hard mudstone.

- Wistow is designed to produce 40,000 t per week with a labour force of 650. The present force of 800 will reduce as mine arterial roadways are completed.

- The mine is presently working one single entry face in the west (close to Permian) and one conventional longwall face in the east (well below the Permian) and 16 headings for face and main roadway development.

- Single entry faces originally on 9 man limit, now 12. Essentially for installation and salvage.

- 12 man exemption requires: (Figure 4-21)
  - BM1 at #7 Chock (where waste flushing starts)
  - BM1 outbye district
  - TX130 at blind end duct
  - CO monitor
  - Smoke detection at fans
  - Vibration monitoring at the fans
  - Telephone/tannoy inbye, outbye and at blind end
  - Use of hand held MSA CH_4 detectors

- Major operational problems:
  - Face creep

- Ramming over AFC
- Keeping up with development

o Dust control good. With 130 l/min to each shearer drum, dust less than 7 mg/m^3.

o Use of recirculation ventilation is under consideration.

o Single entry faces designed at 9.9 mm/m strain.

o Single entry system under properly controlled conditions has proved very safe and cost effective.

o Salvage using rock bolts and mesh over the last few strips has provided a safe, effective and economical support for salvage operations (Figure 4-22).

4.3.2 Sherwood Mine - British Coal

The Sherwood Mine was originally developed in 1902 and has produced coal from seven different seams. It now mines the Deep Hard/Piper Seam (3.1 m); the Yard Seam (1.0 m) and the Blackshale Seam (1.9 m). The mine employs 780 men and produces approximately 18,000 saleable tonnes/week (36,000 t ROM) at an overall OMS of 4 tonnes. The mine is partially located under the residential town of Mansfield and is required to restrict or eliminate subsidence in this area, since subsidence compensation payments have reached $30/t.

This has led to the development of the partial extraction systems using the DOSCO In Seam Miner and the Single Entry Short Longwall Retreat faces. This latter system is also being used at the adjacent Mansfield Colliery. Figure 4-23 shows the location of the partial extraction area and the single entry extraction area.

Summary details of the methods and equipment used in 133's Single Entry Face are given in Table 4-4.

General comments include:

o Seam moderately gassy. Several trip outs on single entry face, usually at #3 chock where fringe encroaches on face.

o Seam is a low risk spontaneous combustion area, and there are no high ignition temperature potential (ITP) strata in or near the cutting sections.

- Floor is strong mudstone with immediate roof being 0.5 m medium shale then strong mudstone.

- The single entry roads were driven by DOSCO road-headers which leave a curved cusp in the roof. Roof beams thus have curved ends to provide support in this area (Figure 4-24). This does not provide the best support at the face entry.

- The cutting sequence and support layout are also shown on Figure 4-24.

- Use of full face in seam miner or single entry longwall retreating faces considered to be only viable means for partial extraction in conditions at Sherwood.

- Sherwood Mine expects to operate several single entry faces to extract the coal under the urban centres.

4.3.3 Mansfield Mine - British Coal

Mansfield Mine is working under the town of Mansfield and has been mining coal since the early 1900's. Mining recently commenced in the Deep Hard/Piper Seam where, in order to keep subsidence to a minimum, a 50% extraction was agreed using 45 m single entry faces with 45 m pillar. To date the mine has worked three faces (Figure 4-25). The first face was not a true single entry, relying on a back return airway. This layout was not repeated due to severe roadway crushing and floor heave and high gas emissions from the waste. Recent faces are true single entry faces using a twin duct ventilation system (Figure 4-26). Details of the equipment and methods used on the present face are given in Table 4-5.

The main problems with the use of the single entry system have been:

- Keeping development drivages and preparation of the next face at the same rate. This becomes the priority area.

- Nine man limit creates difficulties with inspections. This may be raised, by exemption, to 18 during face installation.

- Constant attention to detail required in handling the 900 mm ducting onto the torpedo during move backs.

- Specially designed split stone dust barriers necessary to cover the width of the heading, due to presence of twin ducts in the roadway.

- Only 90% of potential face advance achieved due to steerage of face on the wedge cutting principle.

4.3.4 Allerton Bywater Mine - British Coal

The Allerton Bywater Mine in the North Yorkshire area of British Coal is currently using the Single Entry system to mine under the town of Castleford practising partial extraction methods.

Little information has been made available by the mine. The face is 50 m long and is retreated using an Anderson Strathclyde AM 500 Double Ended Ranging Drum Shearer.

4.3.5 Stolzenbach Mine - Preag. (F.R.G.)

The Stolzenbach mine is operated by Preussiche Elektrizitats AG to supply lignite for a 210 MW thermal generating plant at Borken in Hessen in West Germany. The underground mine supplies approximately 45% of the 1.0 Mtpa requirement of the power plant. The seam varies in thickness from 3 m to 8 m and lies at between 60 m and 160 m below the surface. Initial workings at the mine were by room and pillar methods, and this method is still used in areas where the roof is sand or sandy strata. However, experience at the adjacent Altenburg mine showed that longwall mining was possible where the roof strata became a hard clay. The single entry faces were introduced in 1982 and, to date, some 22 faces have been operated. The face length has varied from 26 m to 50 m (average 41 m) with panel lengths ranging from 160 m to 500 m. The extracted height has ranged from 2.9 m to 3.3 m with both top and bottom coal left.

Details of a typical single entry face are given in Table 4-6 with a typical face layout shown in Figure 4-28. These faces are worked using the Eickhof ESA 60L heading and mining machine. It should also be noted that lignite (brown coal) causes high frictional forces on conveyors and support movement.

4.3.6 Gretley Mine - NSW Australia

Gretley Mine is located at Wallsend in New South Wales and is owned and operated by the Newcastle Wallsend Coal Company. Mining originally commenced in 1861 in the Borehole seam, but current production is from the Dudley Seam which lies between 15 m and 150 m below the surface. The area presently being mined is 70 to 100 m below residential development and partial extraction (60%) is practised to minimize subsidence.

Gretley has always been an efficient room and pillar mine (Figure 4-29) but a change to the single entry or 'mini' longwall has been dictated by more difficult mining and economic conditions. The Dudley seam, which contains 23 Mt of coal, varies from 1.8 m to 2.5 m in thickness and the gradient is flat to moderate. The seam is neither liable to spontaneous combustion, nor gassy. Main access to the mine is through entries in the outcrop box cut. Men and materials are transported by FSV's with special purpose FSV's used for transporting the mini-wall equipment.

Roadways are driven by Jeffrey 1036 full face (4.88 m wide) continuous miners fitted with inboard rock bolters. The roadways are supported by W straps with (4) 1.5 m long bolts.

The single entry mini-wall at Gretley uses the through roadway concept of ventilation, with the roof supports being sealed to force the air along the face and then to return via the waste to the return roadway (i.e. no auxiliary ventilation). The system makes use of the fact that the roof in the waste at Gretley rarely caves until long after the mining of the panel has been completed (Figure 4-30).

Details of the equipment and methods used at Gretley, which is claimed to be the first single entry system which has been custom designed, are given in Table 4-7. Figures 4-31, 4-32, 4-33, 4-34 and 4-35 respectively show a schematic of the mini-wall system, the cutting sequence, face cross section, main gate and blind end arrangements and equipment layouts in the gate road.

The design at Gretley has a number of special features worth noting:

- Single ended short shearer with ability to cut into gate, thus permitting true Bi-di cutting;
- Face conveyor advanced simultaneously in straight line, eliminating snaking;
- Face supports collapse to short transportable length;
- Provides optimum ratio of extraction to development;
- Through favourable non-caving strata circumstances, eliminates auxiliary ventilation systems;
- Particular attention paid to reducing number of components and simplifying system; and
- Use of roller curve conveyor eliminates drive units and transfer point.

4.3.7 #14 Phosphate Mine, OCF - Morocco

In addition to mining phosphate in its surface mines, OCP (Office Cherifien Des Phosphates) has been producing the mineral from a number of underground mines. The mineral is mined from a number of shortwall faces using a variety of plows, shearers and heading machines. In this latter category are four hydraulically powered VM08 Westfalia machines and one electrically powered VME Westfalia machine. This latter machine was used in a single entry system in 1985. The little information available is given below.

Face Length	26 m
Seam Height	2.85 m
Daily Retreat	32.15 m
Daily Output	2851 t
OMS (t)	69
Manshifts/Day	41
Extraction (%)	60

Phosphate is generally an easier cutting proposition than coal but has a higher specific gravity (1.7 t/m^3).

4.4 PREVIOUS USERS:

A number of underground coal mines in the United Kingdom have used the single entry system. Some of these mines have since closed (*) and details are no longer available.

In chronological order, they are:

1980(-85)	Whitwick*
1980	Wath*
1980	South Kirkby
1982	Measham
1983	Ledston Luck*
1983	Royston Drift
1983	Pye Hill*
1984	Cadley Hill
1987	Bevercotes

A brief summary of the known details for each of the above mines is given in the following sections.

4.4.1 Whitwick Mine - British Coal

The Whitwick mine, which was in the old South Midlands Area, is now closed, but between 1980 and 1985, single entry retreat mining

was practised using a DOSCO In Seam Miner with Electric Drive. No other information is available concerning this operation.

4.4.2 Wath Mine - British Coal

The Wath Mine, which was part of the old South Yorkshire Area, is now closed. A single entry face, only 7 m long was worked at the mine in 1980. The only other information available is that the shearer used was an Anderson Strathclyde Single Ended Ranging Drum Shearer.

4.4.3 South Kirkby Mine - British Coal

The South Kirkby Mine is now part of the North Yorkshire Area of British Coal. Many seams have been worked at the mine, creating problems associated with seam interaction. The area worked by the mine also lies beneath relatively densely populated areas. Many areas of coal have thus been sterilized for mining by conventional means. The single entry system was used at South Kirkby to recover some coal from one of these large pillars. An initial trial face was established in 1980 to prove the system and a further three faces were worked in the Newhill Seam (Figure 4-36).

A summary of the methods and equipment used is given in Table 4-8. The face end arrangements of this first face are shown in Figure 4-37, and the ventilation and safety plan is shown on Figure 4-38.

The roadway for the first face was driven by a DOSCO Dintheader with excavated dimensions of 4.57 m by 2.18 m. It was supported by 3.81 m x 1.83 m Hollybank supports (150 mm x 125 mm section). Subsequent roadways were mined at 5.64 m x 2.33 m and supported by 4.88 m x 1.98 m Hollybank arches with splayed legs.

The major problems encountered with the first face were:

- Gate not wide enough to permit shearer to enter roadway, thus forcing machine to cut in on the snake.
- Face/roadway area extremely congested with twin ventilation ducts in the limited roadway section.
- Convergence of roof and floor, especially in area of Meltonfield pillar.
- Considerable goaf side flushing and heavy weighting, due to slow advance arising from gate road/face area problems.

- Ventilation ducting on face extensively damaged during severe weighting and convergence. Eventually replaced by steel box duct attached to AFC spill plate but this jeopardized prop free front distance resulting in smaller depth of cut.

- AFC drive at tailend not successful due to water problems.

  Problems associated with the second face were:

- Despite wider roadway, still had problems getting machine into gate.

By using existing equipment and with the reduction in labour, the second face proved that the system can make a positive contribution to the mine's operations. In producing 42,617 t in 1981, the total revenue was $3.442 M, face costs were $1.561 M giving a contribution of $1.881 M.

The fourth face was designed to use a curved conveyor (to replace the face AFC and the stage loader) and fully shielded 6 legs chock shields.

4.4.4 Measham Mine - British Coal

Measham Mine is in the South Midlands Area and has been producing coal since 1850 from a total of eight seams. Because coal quality was deteriorating as the poorer seams were worked, the single entry system was introduced to recover small isolated parcels of high quality coal which could not be mined by conventional longwall methods.

A piece of coal left between a previous advancing longwall face and a fault was selected, providing an area for a 50 m long face over a panel length of 270 m, bordering the old longwall face return roadway (Figure 4-39).

Details of the equipment and methods used are given in Table 4-9 and in Figure 4-40 (Ventilation plan).

The major problem which was encountered was restricted room in the chocks due to the presence of the 500 mm diameter forcing face ventilation duct which was suspended from the powered supports behind the legs.

Other relevant comments include:

- o use of small maingate stable ahead of face to ensure adequate support of known existing roof breaks above seam at roadside.
- o stable maintained one day's advance ahead of face.
- o face cut by undirectional method, and snaked over from drive head end to connect any tendency for creep.

4.4.5 Ledston Luck Mine - British Coal

This mine, located in the North Yorkshire area, is now closed, but operated a 40 m long single entry longwall face in the Barnsley Bed Seam in 1983. No other information is available, but the experience with this face was used to design the initial single entry faces put into operation at the Wistow Mine (Section 4.3.1).

4.4.6 Royston Drift Mine - British Coal

This mine, now part of the North Yorkshire Area operated a 40 m long single entry face in 1983 with an Anderson Strathclyde double ended ranging drum shearer. No information has been made available by the mine.

4.4.7 Pye Hill Mine - British Coal

Pye Hill Mine, in the South Midlands Area, is now closed, but in 1983 a Single Entry Face was worked using the DOSCO In-Seam Miner on a face 14 m in length (Figure 4-41). The face was established as a trial system in the four leaf Blackshale Seam mining a remnant panel of coal left by a longwall face which finished prematurely due to a zone of sandstone rolls in the roof.

The DOSCO In-Seam Miner is a full face machine which simultaneously cuts the full height and length of the face. It is described in more detail in Section 4-6.

The single entry roadway was driven by a DOSCO Dintheader at an excavated size of 4.1 m x 2.23 m supported at 3.65 m x 2.1 m by 3 piece flat top Hollybank arches set at 1.07 m centres. A 38 cm dint was taken below the seam floor to allow the In-Seam Miner (ISM) to deliver coal onto the stageloader. The ISM was designed to mine 1.53 metres (3 leaves of coal) leaving the fourth leaf in the roof (Figure 4-42).

The details of the equipment and methods used are given in Table 4-10. Figures 4-43 and 4-44 show respectively the ventilation and support arrangements.

The major problems encountered during the working of this face were:

- top coal (4th leaf) would not stay up, slowing down mining operations.
- occasional difficulty loading out from ISM onto belt conveyor due to variations in depth of dint.
- Roadway powered supports tended to wander.
- The ISM tended to creep into the gate. This was corrected by keeping the gate end of the face 0.6 m ahead of the blind end.
- Heading was not wide enough. Interference arose between ISM, conveyor and ventilation ducting.
- Removal of steel lagging sheets ahead of face proved difficult.
- Because ISM is rigid, face could not cope with sudden short changes of gradient such as swilleys.

4.4.8 Cadley Hill Mine - British Coal

Cadley Hill Mine is part of the South Midlands Area and is presently producing 0.45 Mtpa of saleable coal from three seams in the Western Extension of the mine which is in an extremely complex geological area with heavy faulting and steep gradients.

The single entry system was used to recover a narrow block of coal between two faults (Figure 4-45) in the Stocking seam.

The Stocking Seam is 2.25 m thick and contains a 20 cm dirt band. The roof is a friable mudstone, so 27 cms of coal are usually left in the roof to provide stable conditions. The single entry face SE1 commenced production in 1985.

Details of the equipment and methods used on the face are given in Table 4-11, with details of the ventilation, roadhead support, face section and cutting sequence being given in Figures 4-46, 4-47, 4-48 and 4-49 respectively.

Other points of interest include:

- o Surface mock-up established for training purposes prior to operations
- o No person allowed to be inbye any support being moved.
- o Face operated on a short face version of the 'half and half' system because gave:
  - minimum cycle for maximum shears per shift
  - maximum depth of cut
  - complied with and obviated any delays due to restriction of no people inbye supports being moved.
- o Actual performance data and details of operational problems have not been made available.

4.4.9 Bevercotes Mine - British Coal

Bevercotes Mine is located in the Nottinghamshire Area of British Coal. In late 1986, the last conventional retreating longwall face in the NW section of the Parkgate seam was being developed. Following completion of the 600 m long main and tail gates, a 2.5 m fault was encountered whilst driving the face line. Seismic surveys from the gates showed that it made the conventional face inoperable. It was therefore decided to work the face as a 60 m long single entry face (Figure 4-50). The Parkgate seam is 1.5 m thick and the 99A face commenced production in early 1987.

Details of the equipment and methods used on this face are given in Table 4-12. The roadway was developed for the conventional retreating face with a 1.3 m dint. Problems were encountered with the single entry workings with weak roof conditions especially in the roadhead area, and together with extensive crushing and floor heave in the same area affected the stability of the face supports at the roadside.

Heavy flushing through the chocks and water percolation from pre-drilled methane drainage holes also affected operational conditions.

The dint aggravated the stability of the first face support, and made creep problems even worse.

Floor lift, the crushing in the front abutment zone and the use of twin ventilation ducts all made face access difficult.

Due to poor conditions and the corresponding shortfall in results, the unit was abandoned after 140 m of retreat in 12 weeks. The best weekly output (10 shifts) was 2400 tonnes.

4.5 PROPECTIVE USERS

A number of mines in various parts of the world are considering the use of the single entry system for either the recovery of remnant areas of coal and coal pillars or as a production system.

Little advance detail is available, however, a 50 m long face using a Westphalia VME heading machine as the production machine in a 1.9 m thick seam at the Norgrad Mine in Hungary is due to commence operations in June 1988.

In addition, two single entry faces were planned at the Rheinland Mine of the Niederrhein Division of Ruhrkohle, AG in West Germany. These were never implemented due to the promotion of the Mine Director to Divisional Headquarters, but details are given in the following section.

4.5.1 Rheinland Mine - Ruhrkohle

The Rheinland Mine complex of Ruhrkohle consists of two mines, Pattberg and Rossenray. The Rossenray Mine is working at an average depth of 900 m whilst the Pattberg Mine is operating at an average depth of 650 m.

The seams mined range from 1.6 to 2.0 m with the total capacity of the complex being in excess of 20,000 tonnes per day.

The mine had been seeking ways and means of economically mining remnant areas of coal which could not be extracted using conventional methods, and also to mine other reserve areas on a partial extraction basis, particularly where rock mechanics and subsidence considerations were paramount.

In conjunction with the Third Innovation Program of BMWi, a single entry system was designed for two faces at the Pattberg Mine to be worked (Figure 4-52) in the Hermann-Gustav seam (1.95 m) from a single through roadway with auxiliary ventilation to the face. The design was based on the use of the Eickhoff ESA 150L heading and coal winning machine working in conjunction with powered supports containing a personnel escape tunnel and special roadway support techniques to enable the roadway in the waste area to be used as a ventilation airway and reused for the second face. Figure 4-53 shows the proposed face layout, and Figure 4-54 gives the section

through the face. On this section, the escape duct can be clearly seen located between the shield legs and the lemniscate linkage.

.1 Emergency Egress/Ventilation Duct

The German mining regulations (§145 Abs, 2B VOst) require that every working place in active ground must have two means of egress and ventilation. No exception was granted for this face, thus a ducting was incorporated into the face supports. This acts normally as the forcing ventilation ducting for the face, but has access doors at regular intervals to facilitate its use as an emergency egress. Its size (0.6 m^2, 850 mm wide) and shape (trapezoidal) are such that it is not damaged when the face supports bottom. The duct is one rigid unit with its own advancing rams, and the sequence of movement is shown in Figure 4-55. A prototype length has been successfully tested in an operating mine. The powered supports were also modified with extended cantilevers and the last roof support unit in the blind end was to be fitted with side plates and sprags to prevent coal and adjacent strata from spalling into the face. The ventilation fan proposed had a dual power facility, being capable of operation by either an electric motor or by compressed air.

.2 Roadway Support

The roadway to be used for the single entry mining is supported by four piece U section yielding arches 5.0 m x 3.5 m. It was proposed that rock bolts would be used in the roadhead area to provide additional support. The face side shoulder of the arch would be supported by a bracket and two rock bolts to maintain stability when the face side leg is removed. Two additional bolts were placed in the roof strata immediately above the face opening for reinforcement (Figure 4-56).

Because the roadway was already driven with an 80 cm dint, to accommodate seam gradient the first shield was set some two metres in from the roadside, with the intervening roof supported by sliding roof bars and hydraulic props (Figure 4-57). In addition a monolithic pack, 0.7 m wide was put on at the roadside to within 5 metres of the face.

.3 Production Machine

The design proposed to use the Eickhoff ESA 150 heading machine operated by radio remote control. This is an upgraded version of the basic heading machine which is described in Section 4.6.

A summary of the major features of the proposed face are given in Table 4-13, and a copy of the conditions laid down by West German Mines Inspectorate are included in Appendix D. The approved

system was not put into operation due to the promotion of its proposer, the Mine Director. The new Mine Director has yet to proceed with the system.

4.6 MACHINES FOR COMBINED ROADWAY DRIVAGE AND FACE EXTRACTION

One of the variations possible within the basic single entry system is to use one cutting machine to drive the single entry roadway and the face line, and then mine the short face on the retreat. Although this principle has not yet been tried in practice, three manufacturers can provide equipment which should be capable of fulfilling this requirement.

The applicable equipment is supplied by:

- o DOSCO (UK) - In Seam Miner - ISM 2000
  - ISM 3000
- o Eickhoff (FRG) - ESA Shearer Loader - ESA 60
  - ESA 150
  - ESA 300
- o Westfalia (FRG) - Mining & Heading Machine - VME

The machines are briefly described below.

4.6.1 Dosco In-Seam Miner

The In-Seam Miner is an electrically driven full face machine which excavates a pre-determined fixed width of heading and a pre-determined, slightly variable height.

The machine is powered by two cutter motors, one at each end (Figure 4-58), which drive a cutter chain which also contains the loading buckets. The main components of the machine are:

- o cutting jib
- o main frame
- o staker chocks
- o cutter motors
- o push rams
- o conveyor
- o power pack

Beyond a 150 cm height variation achieved by altering pick lacings, height and width can only be changed to suit specific seam and heading requirements by changing components. Table 4-14 lists the

operating ranges, including the ISM 3000 which is a double jib machine for use in the thicker seams (Figure 4-59).

By virtue of its construction, the machine cuts a roadway with a flat roof and floor but curved ends, and can be applied in seams ranging from 0.86 m to 3.15 m. The cut coal is collected by the buckets and discharged onto the machine conveyor.

The unit is advanced into the coal face by staker chocks and rams which also provide lateral steering control. Vertical steering is provided by rams mounted between the cutting jib and the main frame.

The major advantages with this type of machine are:

- continuous cutting action
- permits simultaneous cutting and support setting
- support can be set within 1 m of the face
- rock bolting and support setting devices can be fitted to the machine
- provides protection from falls of face
- simple robust construction giving high availability and low maintenance
- ventilation ducting can be attached directly to cutting head
- use of exhausting duct to machine effectively keeps dust and methane under control due to shrouding effect of full face cutting jib

The major disadvantages are:

- cannot cope with varying seam heights or undulations along face
- limited to maximum length of 15 m
- curved sides can present support problems in soft coal conditions, and may require special support
- difficult to manoeuvre through 90° without either extra headroom or partially dismantling cutter jib, although can cut round 25 m - 30 m inside radius curve

More than 170 in-seam miners have been put into operation. Of these, 130 were hydraulically powered machines which have now been superseded by the electrically driven machines. The modern electric ISM is now working in UK, USA, S. Africa, W. Germany and Australia. The electric ISM's have been used for rapid in-seam drivage, advanced headings, partial extraction and as the producing machine on a single entry face.

Typical performances are:

<u>Roadway Drivage</u>

ISM 2000 (UK)	50 m/shift 367 m/week (10 shifts)
ISM 3000 (UK)	15.6 m/shift (avg) 116.4 m/week (10 shifts) 1876 t/week (10 shifts)

<u>Partial Extraction</u>

ISM 2000 (UK)	29 m/shift (best) 13.7 m/shift (avg) 1830 m in 132 shifts

A description of an ISM 3000 being used for heading drivage prior to undertaking partial extraction mining at Sherwood Mine is given below.

The Sherwood Mine was originally developed in 1902 and has produced coal from seven different seams. It now works the Deep Hard/Piper Seam (3.1 m); the Yard Seam (1.0 m) and the Blackshale Seam (1.9 m); the mine employs 780 men and produces approximately 18,000 saleable tonnes/week (36,000 t ROM) at an overall OMS of 4 tonnes. The mine is partially located under the residential town of Mansfield and is required to restrict or eliminate subsidence in this area.

This has led to the development of the partial extraction systems using the DOSCO In Seam Miner and the Single Entry short longwall retreat faces.

Summary details of the methods and equipment used in the In Seam Miner (ISM) drivage are given in Table 4-15.

General comments include:

1. Seam moderately gassy. No trip outs in ISM heading.

2. Dosco ISM 3000 will be used with JCM, each driving alternate 7.3 m wide headings with 7.3 m pillars to give 50% extraction.

3. Floor is strong mudstone with immediate roof being 0.5 m medium shale then strong mudstone.

4. Performance of other heading machines:

   Dosco Mk 2A - 45-50 m/week
   Dosco L1300 - 3 m coal - 100 m/week
   Dosco L1300 - 1 m coal, 2 m stone - 60 m/week

5. ISM Heading. If can use rock bolts and mesh instead of flat top arches and mesh in partial extraction, estimated saving of $700,000 per year.

6. Use of full face in seam miner or single entry longwall retreating faces considered to be only viable means for partial extraction in conditions at Sherwood.

7. ISM 3000 in Australia at 5.4 m wide and 3 m height, averaging 9 m advance per shift with roof bolts only. Nine 2.1 m long, 24 mm resin bolts and straps and mesh. Spacing 0.75 m, 5 vertical bolts and 2 inclined over each rib.

4.6.2 Eickhoff ESA Mining Machines

The Eickhoff ESA mining machine was initially developed at the Zolder Mine in Belgium to form stable holes in advance of plough and shearer faces, and for driving face lines. The range of application has since extended to include roadway development and shortwall and single entry production mining.

The ESA machine is essentially a short bodied single drum shearer with a cutting drum mounted on an arm located in such a manner that it is capable of 360° rotation (Figure 4-60). This is achieved by mounting the machine body on a high underframe, or hydraulically raising the machine body.

The main components of the machine are:

- cutting drum
- ranging arm
- main body/underframe
- cutter motor (electric)
- rack haulage drive and motor (hydraulic)
- ranging arm drive and motor (hydraulic)
- curved conveyor

The ESA 60 range of machines is based on a 60 kW electric cutter motor and comprises the 60L, 60-2 and 60K models. Typical dimensions and layout for the 60L and 60K are given in Figures 4-60 and 4-61 respectively. The maximum cutting height of the ESA 60L ranges from 1.4 m to 3.2 m depending on the length of the ranging arm and the drum diameter. The equivalent figures for the 60K are from 1.50 m to 3.6 m.

The components of the machine are supported on the underframe which slides on shoes and the face side trapping arrangment on the conveyor furnishings thus guiding the machine.

The centrally located electric motor drives the drum and the hydraulic pumps for the pivoting gearing of the ranging arm as well as the haulage unit. The ESA-60-2 is an exception in as much as each of the two laterally arranged electric motors drives a cutting drum and one of them also drives the hydraulic pump of the haulage unit.

The ESA machine haulage is driven by a hydraulic motor. The haulage sprocket is positioned on the goaf side and is part of the Eicotrack system by means of which the machine travels along the face.

All versions, with the exception of the ESA-60-2, are equipped with a ranging gearbox which allows the ranging arm to rotate through 360°.

The ESA-K series can raise the machine body by means of a hydraulic cylinder which is attached to the middle of the machine. The maximum tilting angle of the machine body in relation to the underframe is 65°. Lifting the machine allows the maximum cutting height to be reached and enables the ranging arm to be swung around at floor level.

Figure 4-62 shows the method of cutting using the wedge principle for drivage of headings and stables.

The ESA-150 range of machines (Figure 4-63) is based on a 150 kW electric cutting motor and comprises the 150L and 150K models. The basic principles are the same as for the ESA-60, however, the 150L has a cutting range from 1.8m to 3.5m whilst the range for the 150K is from 1.8m to 4.2m. The ranging arm is still centrally mounted on the machine body, but the machine body length has increased from the 1.465m for the ESA-60 to 3.20m which is still considerably less than the standard shearer. The ESA-150 operates on the standard EKF2 curved (or straight) conveyor fitted with conventional furnishings (Figure 4-63).

A more powerful version of the ESA machine, an ESA 300 is currently under development and is expected to be in operation in the latter half of 1988. The machine body length will increase to 3.94m and unless the seam height is greater than 3.33m (to enable the arm and drum to rotate through 360°), it will in effect operate as a single ended ranging drum shearer.

Eickhoff has produced more than 85 ESA machines, 20% of which have been of the 150 type. More than 80% of the ESA machines are operating outside West Germany, in Belgium, Yugoslavia, Czechoslovakia, Hungary, Poland, UK, France and Bulgaria. All the ESA-150 machines are working as production machines on shortwall faces as are a few of the ESA-60 machines. The approximate usage of all machines is:

- stable holes and advance headings - 43%
- roadway and face drivage - 23%
- shortwall and single entry - 35%

Figures 4-64 and 4-65 show typical layouts for heading drivage and single entry faces. The single entry cutting sequence is shown in Figure 4-67.

The major advantages of this type of machine are:

- short robust simple machine
- can readily adjust cutting height to cope with seam variations
- cutting width can be adjusted by adding or subtracting conveyor pans and furnishings
- can be operated on straight or curved conveyor
- can operate on steep and cross gradients
- can be manoeuvered through 90° if discharge conveyor shortened
- face length not restricted

The major disadvantages of the machine are:

- leaves curved side to roadway which could give support problems in friable coal and possible need for special roof supports
- ESA-60 underpowered as a longwall face production machine

- o ESA-60 requires a special conveyor whereas ESA-150 uses standard AFC

Typical performances are:

ESA-60

Single Entry Face	10 m/day
Roadway Drivage	15 m/day
Shortwall Face	14,250 t/week

4.6.3 Westfalia VME Mining and Roadheading Machine

The Westfalia VME mining and roadheading machine is designed, as the name implies, for roadway and face line drivage and for the mining of pillars and remnant areas by shortwall and single entry short longwall faces.

The VME system comprises a cutting machine and a curved conveyor arranged in an L-form with a curved 90° pan (Figure 4-68).

The conveyor provides the base on which the cutting machine rides. The length of the conveyor along the coalface and of the discharging conveyor can be varied to suit the individual application. Currently the VME is available in two versions differing in overall machine height. For a conversion, only a bracket, a boom, and two lifting cylinders are required.

A chain haulage system, hydraulically driven and tensioned, pulls the cutting machine along the conveyor. The captive-guided underframe carries the ranging arm with its two cutting heads. The ranging arm consists of the boom, the cutting head motor and planetary gearboxes. The cutting heads are equipped with replaceable, front and peripheral picks and load the mined material onto the conveyor. The haulage system is powered by a continuously variable hydraulic drive. Hydraulic rams push the machine forward towards the face. Steering rams at the end pans and the curved pan control the direction of advance. The mining machine is equipped with a dust supression system.

A hydraulic power pack and the electrical gearbox are mounted to the rear of the operators canopy. Two staking jacks (or powered roof supports [Figure 4-69] where desirable or necessary) are used to advance the machine.

The machine width can be varied by adding or removing conveyor sections which vary in length from 0.75m to 3.0 m. The minimum width of machine is 4.3m with a maximum of 50m. The longer units require a heavier conveyor and 26mm (instead of 19mm) haulage

chain. The low height machine has a cutting height of 1.0 m to 2.5 m, whilst that for the high machine ranges from 1.5 m to 2.85 m. The cutting unit is powered by a 120 kW electric motor. (Earlier VM08 machines had hydraulically powered cutter motors). The cutting unit has two cutting drums carried on a shaft parallel to the face. The latest drums are fitted with pick face flushing for dust suppression purposes.

The machine cuts a flat roof and floor and produces vertical sides to the roadway with no cusps at the top or bottom. The normal cutting sequence is for the cutting drums to be sumped into the face at floor level by advancing the whole machine. The cutter is traversed across the heading to the other side; the boom is raised, traversed back cutting and the process repeated until the full height of the face has been cut. The cycle is then repeated.

New developments include a split boom machine. This has a separate and independent boom and motor for each cutter drum and is currently under test in the Kali-und-Salz potash mine in Germany. Early results in a 8.5 m wide by 2.2 m high face are advances of 13 m/shift using rock bolts as roof support and a split push/pull anchor system.

The machine is capable of operating on steep gradients with powered supports acting as the anchor and advance system (Figure 4-70).

More than 24 of the hydraulically driven VM08 machines and over 40 of the electrically driven VME machines have been put into operation. The VME's are being used in Canada (CBDC), UK, West Germany and Morocco. Most of them are being used for roadway drivage, including the three Canadian machines. The UK machine is expected to be used on a single entry face whilst the Moroccan machine is working variously on single entry and shortwall faces.

The major advantages of this type of machine are:

- short robust simple machine
- can readily adjust cutting height to cope with seam variations
- cutting width can be adjusted by adding or subtracting conveyor pans and furnishings
- can be operated on standard straight or curved conveyors
- can operate on steep and cross gradients

- can be manouevred through 90° but need to shorten discharge conveyor and reposition power pack
- face length not restricted
- cuts vertical sides to roadway enabling effective support to roadway sides

The major disadvantages of this machine are:

- method of cutting may leave cusp on floor in hard coals
- high haulage speed (20m/min) may cause control problems on longer faces due to operator need to keep up with machine

Figures 4-71, 4-72 and 4-73 show face layouts for a single entry face and a single wide heading used to create a three entry system using two monolithic packs. This latter method, used as either a two or three entry system could be used to serve 1 (two entry) or 2 (three entry) short longwall single entry retreating faces and provide an additional entry from which methane drainage could be undertaken behind the retreating face.

Typical performance data for the VME machines are:

- Roadway Drivage - 110 m/week in 5 m x 2.9 m road.
  - 30 mpd (best), 16.3 mpd (avg) in 6.5 m x 2.1 m road.
  - Avg 9 m/shift over 2 years in 4.2 m x 2.20 m road.
- Shortwall Face - 26 m face x 2.85 m - 32 m/day 2850 tpd

4.6.4 Machine Selection

The selection of a machine for the Prince Mine conditions to drive the single entry roadway, open up the face line and mine the short face on the retreat, will be primarily dependent on the seam conditions.

The selected machine has to be capable of mining at varying seam heights and of coping with undulations along the face. This requirement plus a need for faces of at least 25 m length eliminates the DOSCO In-Seam Miner from consideration in the CBDC mines for single entry face operations.

The ESA 60 machine does not have enough cutting power available (since the cutter motor also drives the hydraulic pumps for the haulage and arm rotation) to be able to produce at a high enough rate for a powered support equipped face. Apart from the Stolzenbach mine in soft lignite, no single entry face has operated with less than 150 kW power to the face machine.

The choice is therefore between the Eickhoff ESA 150 L and the Westfalia VME machines. Table 4-16 lists the major characteristics of both machines.

There is very little to choose between the ancilliary equipment requirements and performances of these two machines. One major point of concern with the ESA machine is the support problem which would arise in CBDC conditions with the curved cusp left at the sides of the roadway, since support at face/roadway interface is a major concern at CBDC mines.

With the VME machine, the major area of concern is the ability of the operator to maintain contact with the machine cutting at 20 m/min. This may require machine operation to be batched along the face by more than one operator.

Since the VME gives better ribside conditions in roadways, and also since there are three machines at work in the CBDC mines on roadway drivage and face opening, the VME has been used for the development of the single machine, single entry variant in this report.

4.7 SINGLE ENTRY SHORT LONGWALL SYSTEMS USING ONE MINING MACHINE

In most cases, attempts to utilize a machine designed for a specific purpose in an alternative mode result in a compromise of the original function and the additional function, to the detriment of both.

Both the ESA and VME machines were first applied to the drivage of roadways and face lines, and the operation of stableholes, a function which they perform admirably. This is because their power is concentrated in a small working area, and their design allows support to be set whilst cutting continues. This enables them to outperform other types of roadway drivage machinery, such as continuous miners and roadheaders which normally have to stop whilst support is being set.

However, when they are applied to production operations on a coal face, they gain no such advantages since they are both generally of much lower power (120 - 150 kW) compared with the modern single

ended or double ended shearer (225 - 375 kW). The use of ESA 150 and VME machines for face production cannot therefore be expected to give rise to production rates associated with conventional longwall face equipment.

A comparison between a single entry face equipped with a conventional shearer, and one equipped with an ESA or VME machine shows very little difference as can be seen in Table 4-17.

The advantages in using one machine for all drivage and mining functions are:

- Considerable saving in time and cost since no need to dismantle and withdraw heading equipment.
- Better utilization of equipment.
- Face can be equipped with powered supports whilst being driven, as drivage machine does not have to be withdrawn on completion.
- Capital cost lower as only need one machine instead of two different ones.

The disadvantages are:

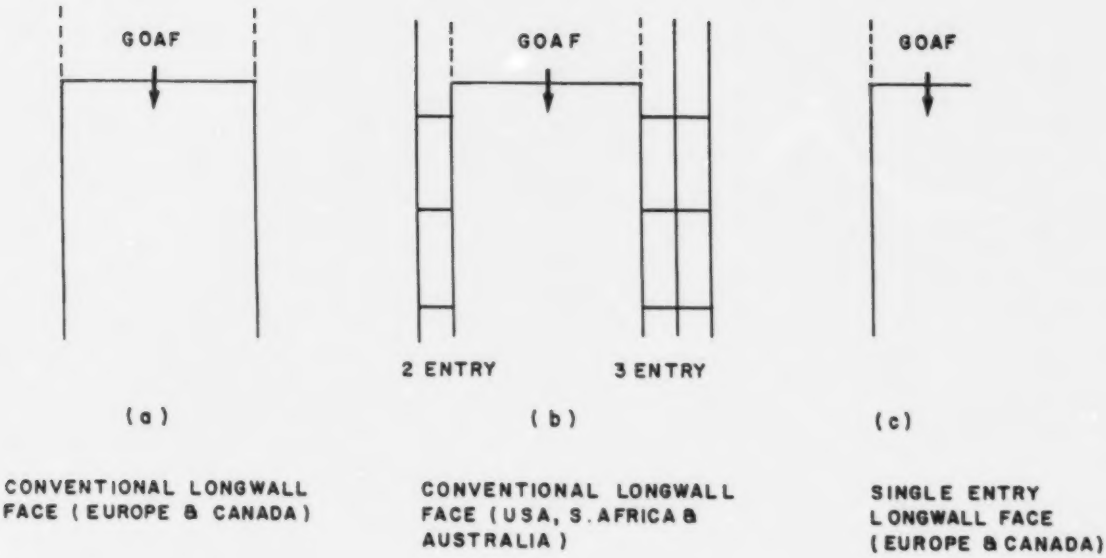
- Production rates per unit of face length, per powered support, or per unit of capital cost are lower.
- The combination has not yet been operated in any mine in Europe, North America or Australia.
- Mine operator's preferences are almost always to use a separate and different machine for the mining of the short retreating face.
- Heading machines do not generally have such features as ventilated extraction drums for the control and ventilation of methane and dust around the cutting drum.

The selection of either a conventional shearer, or heading/face machine for mining the single entry face is dependent on three major factors which are site specific.

- Evaluation of production level expected from the retreating face.
- Methane emissions and need for ventilated (RAC) drums, (not available on heading machines).

- Capital and equipment availability.

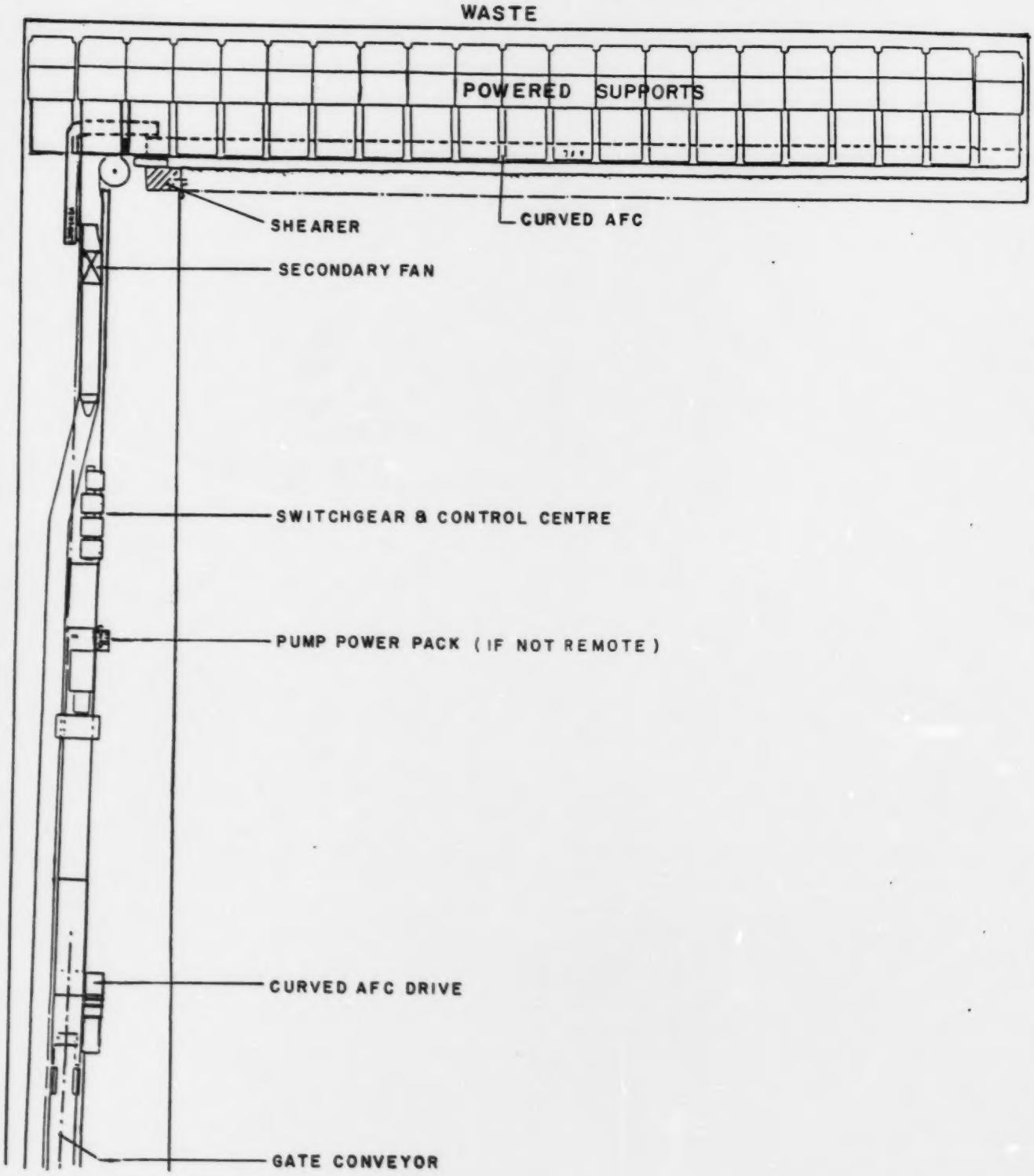
These are decisions that can only be made by the mine contemplating using the single entry system.



DEFINITION OF SINGLE ENTRY FACE

(Source: Monenco)

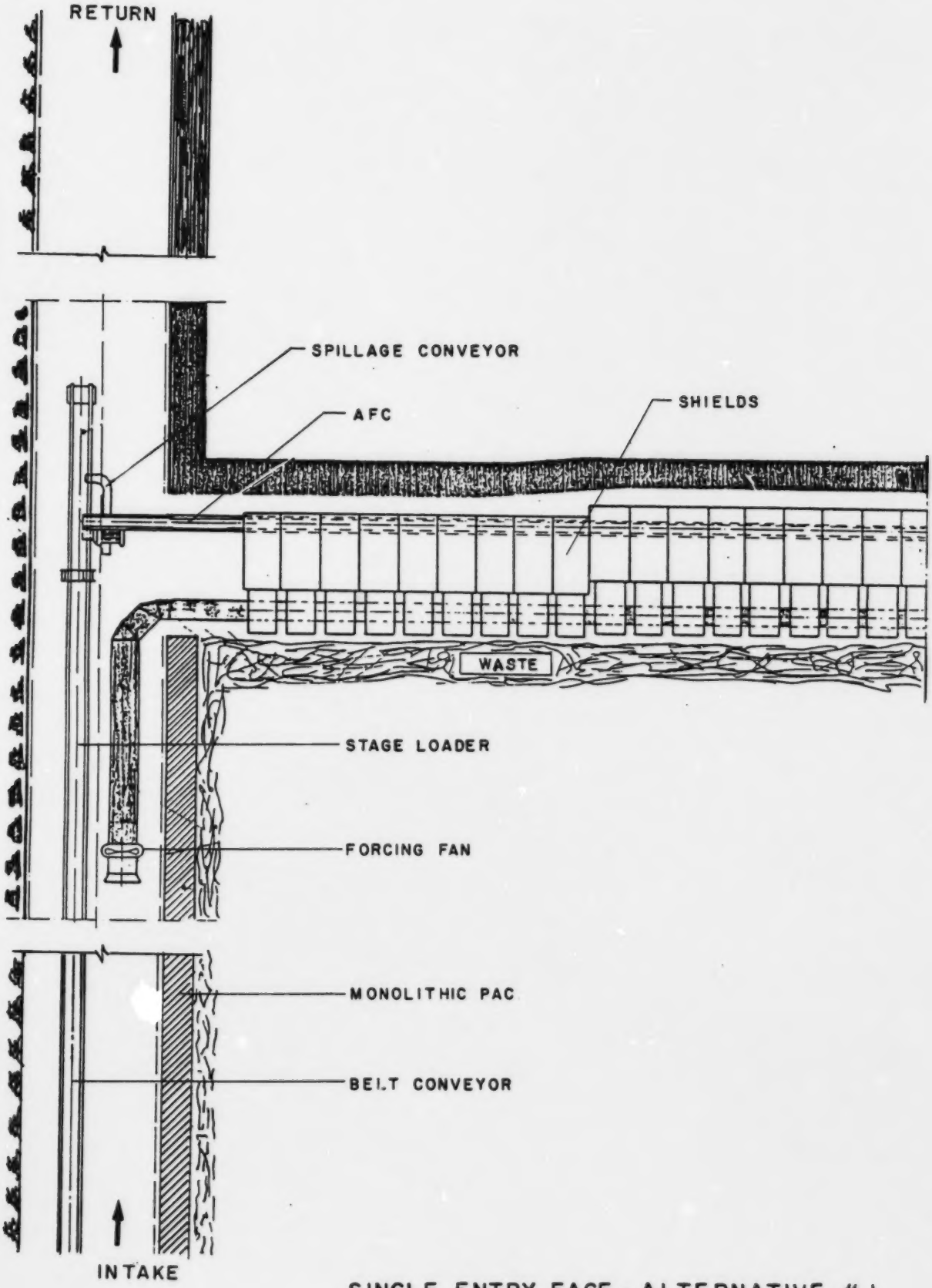
FIGURE 4-1



SINGLE ENTRY FACE - BASIC LAYOUT

FIGURE 4-2

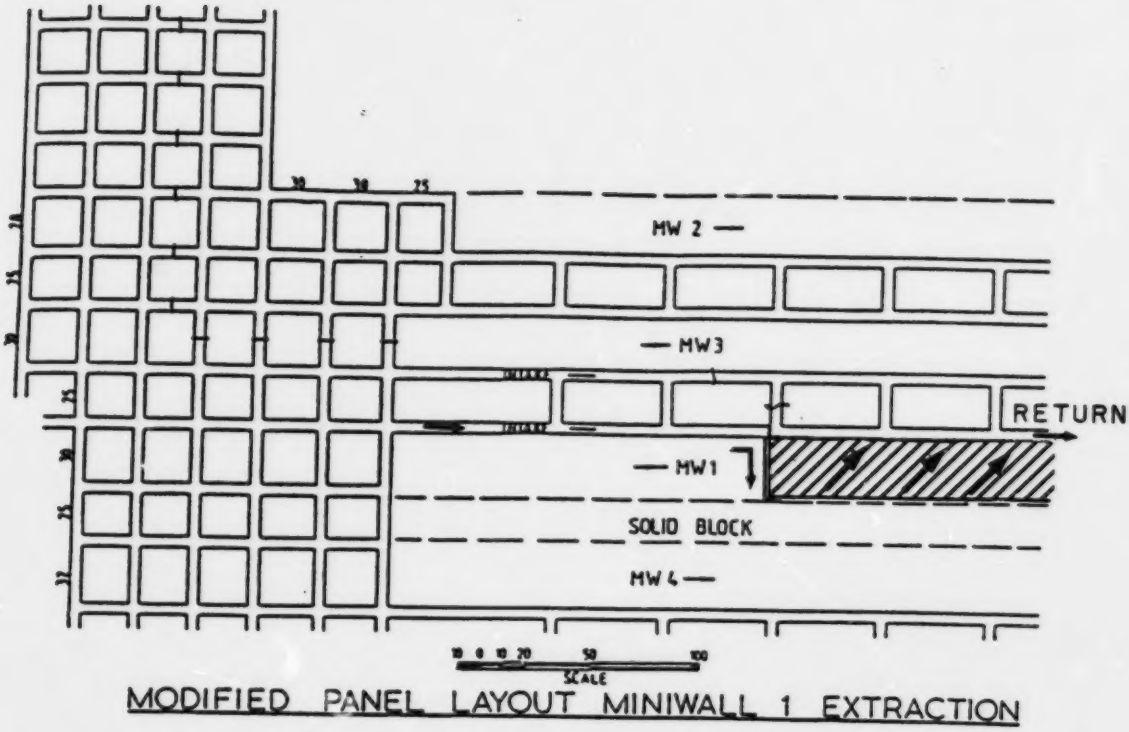
(Source: Ref.A2)



SINGLE ENTRY FACE - ALTERNATIVE # 1

(Source: Ref.A16)

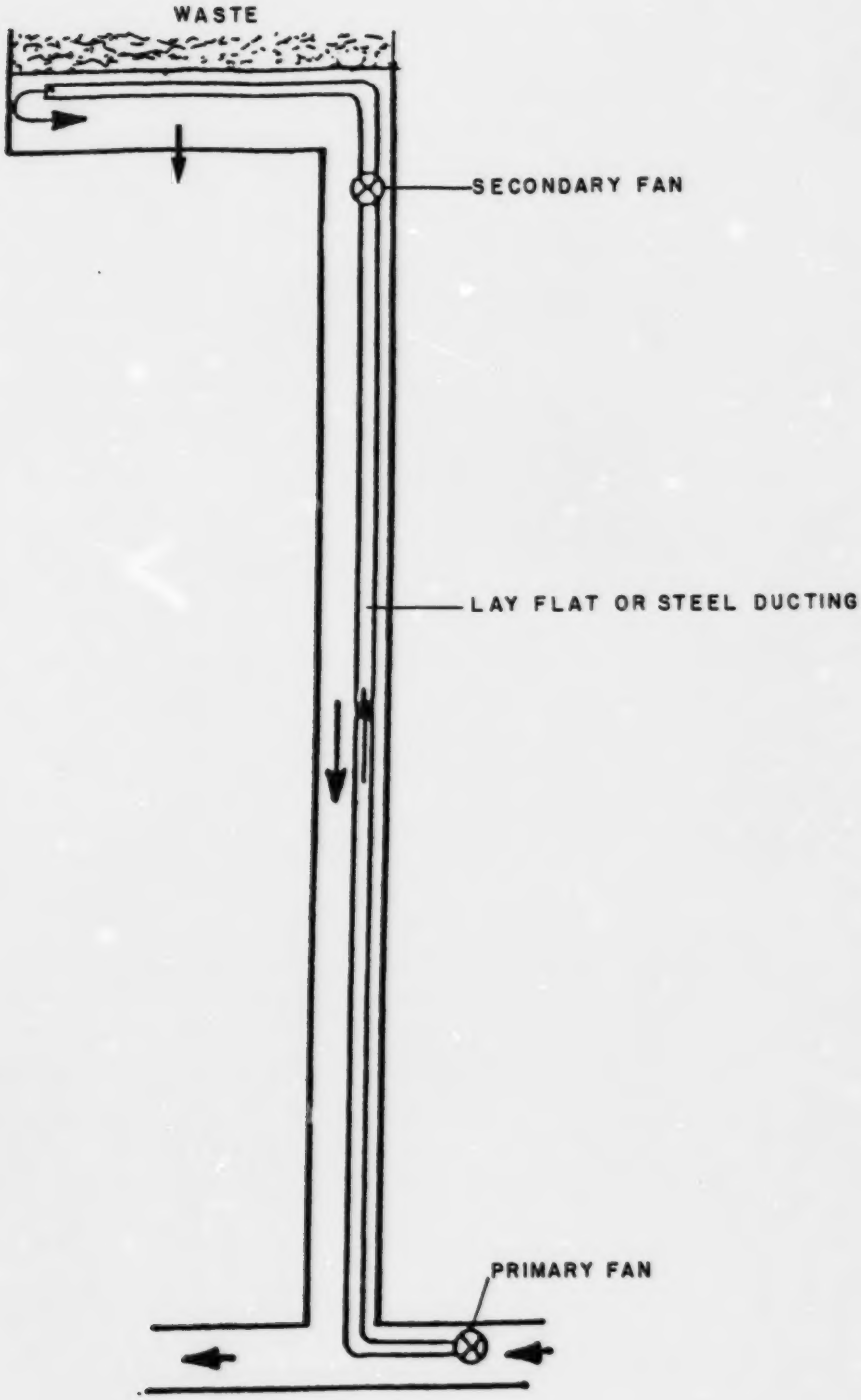
FIGURE 4-3



SINGLE ENTRY FACE - ALTERNATIVE # 2

FIGURE 4 - 4

(Source: Ref.A12)

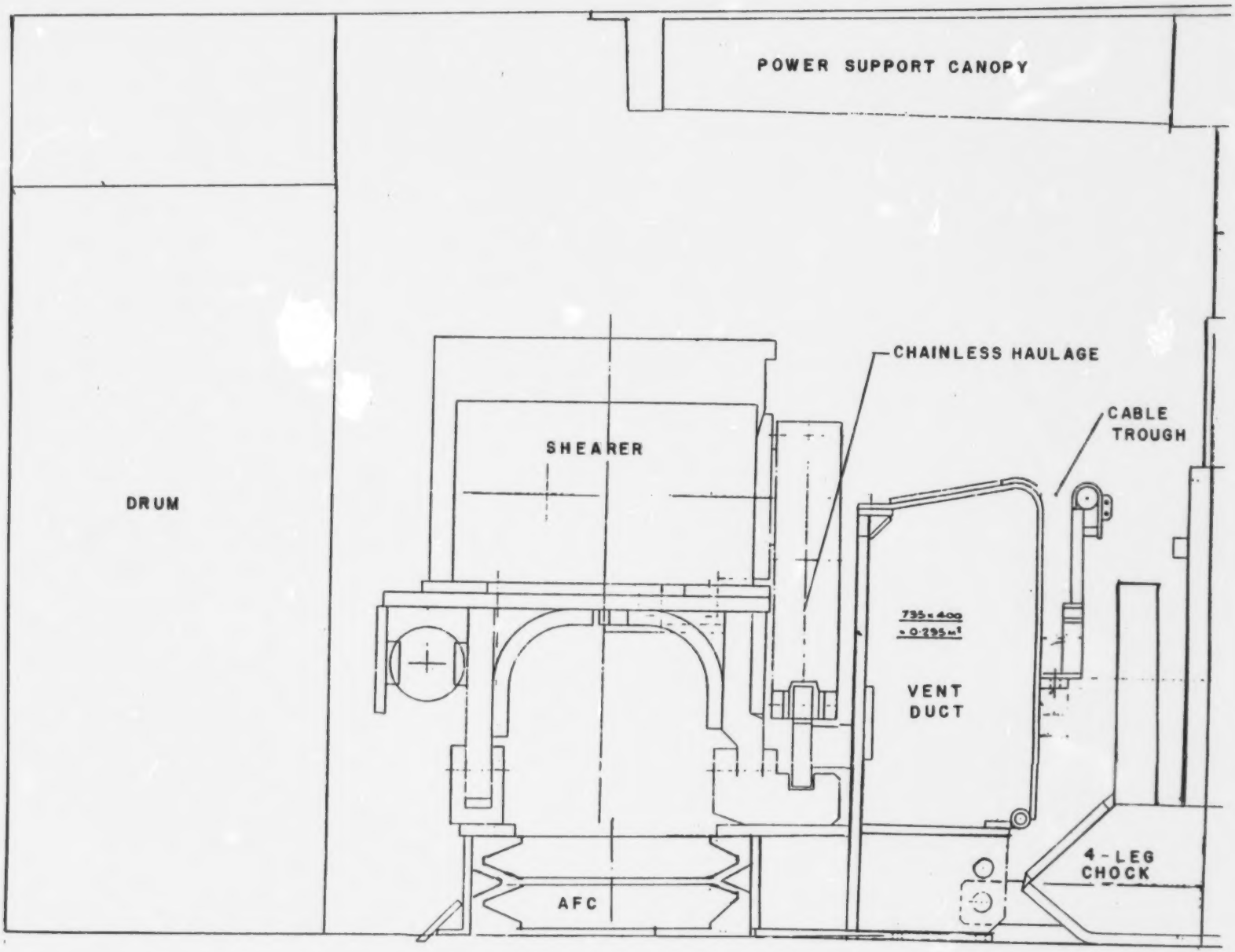


VENTILATION SYSTEMS - SINGLE ROADWAY DUCT

(Source: Monenco)

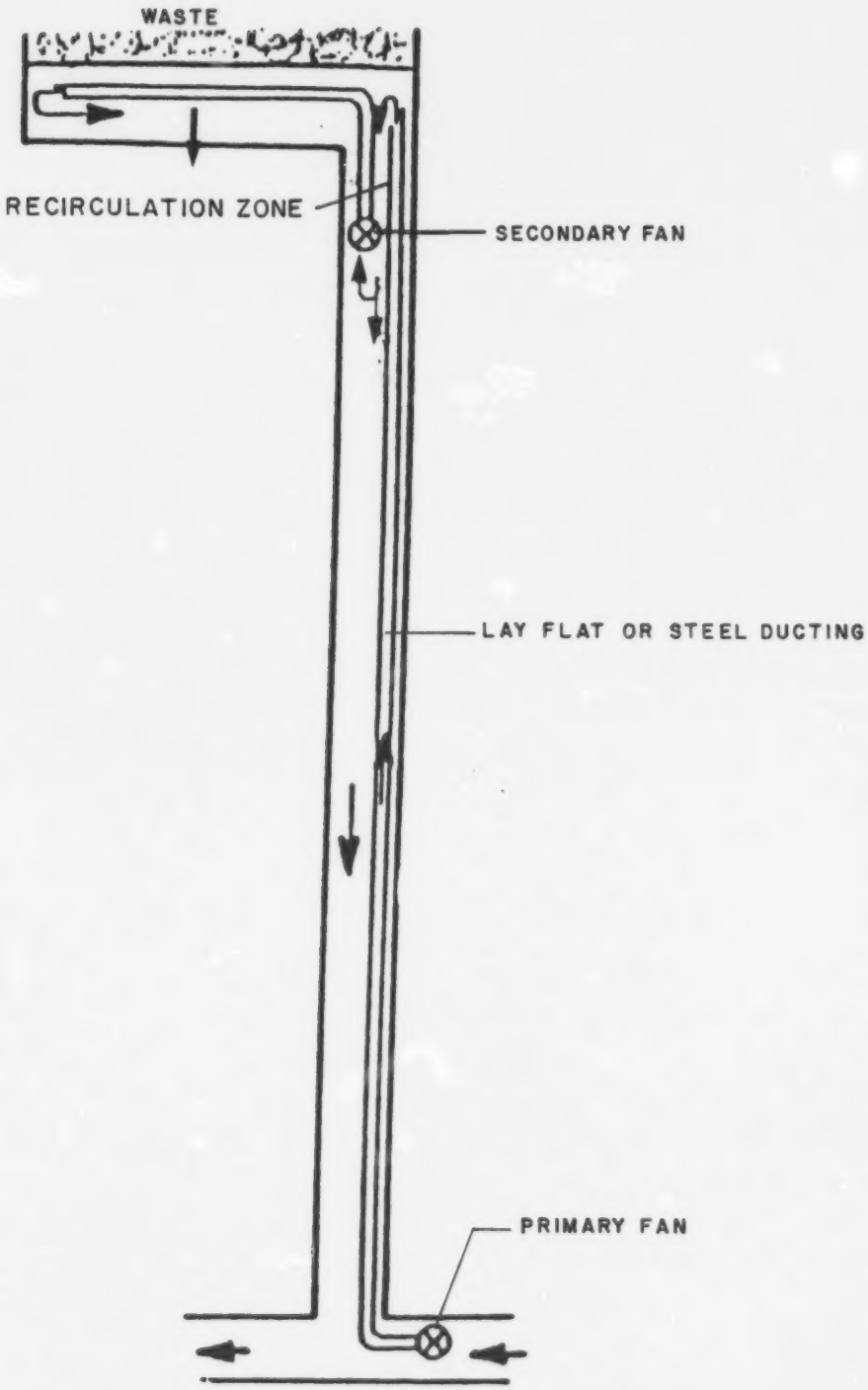
FIGURE 4 - 5

FIGURE 4-6



FACE VENTILATION DUCT

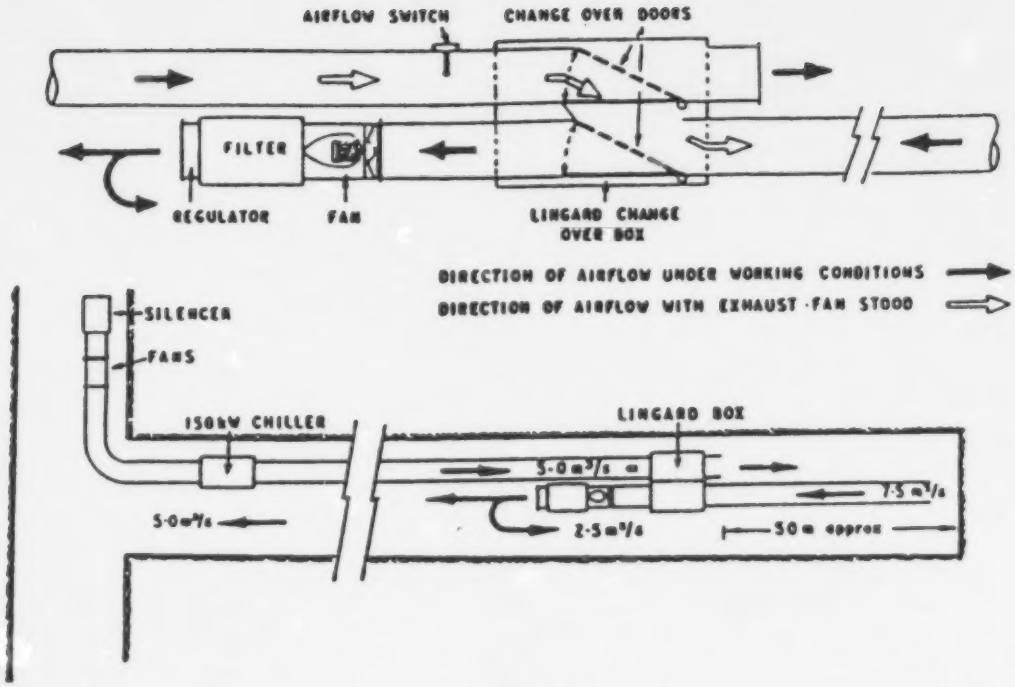
(Source: Pitcraft)



VENTILATION SYSTEMS - RECIRCULATION

(Source: Monenco)

FIGURE 4-7

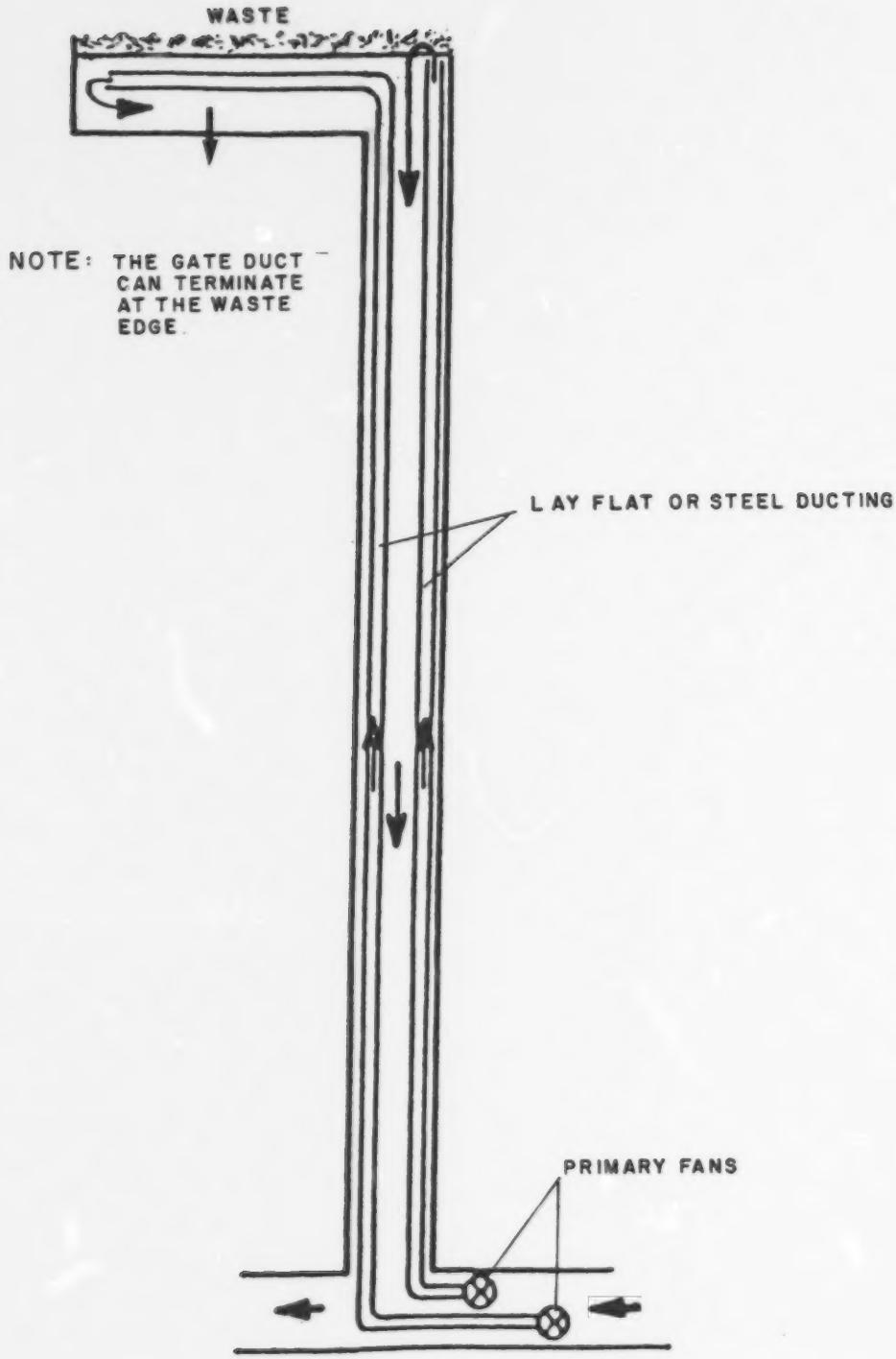


controlled air recirculation system

CHANGE OVER BOX

FIGURE 4-8

(Source: Ref.D13)



VENTILATION SYSTEMS - TWIN ROADWAY DUCTS

(Source: Monenco)

FIGURE 4 -9

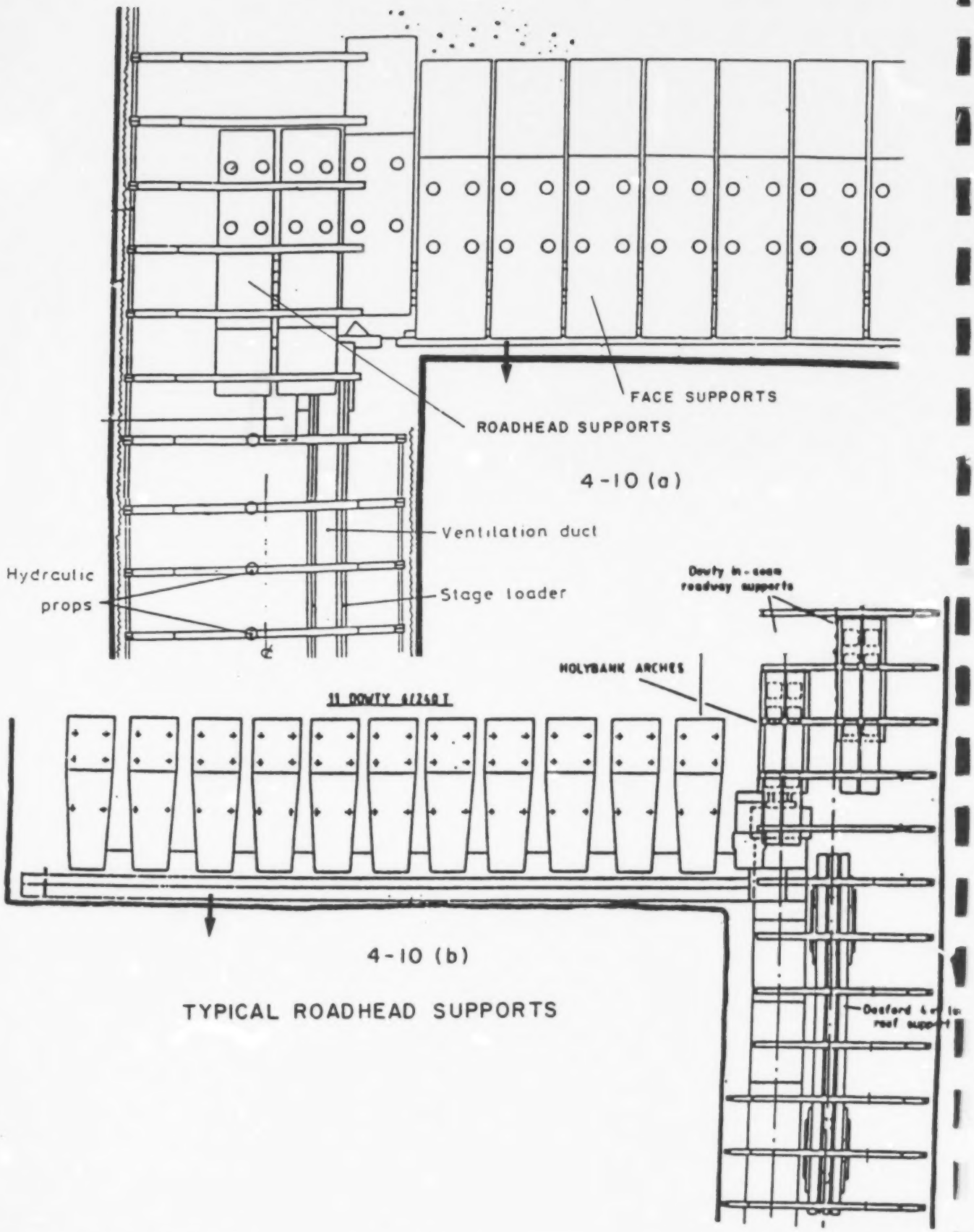
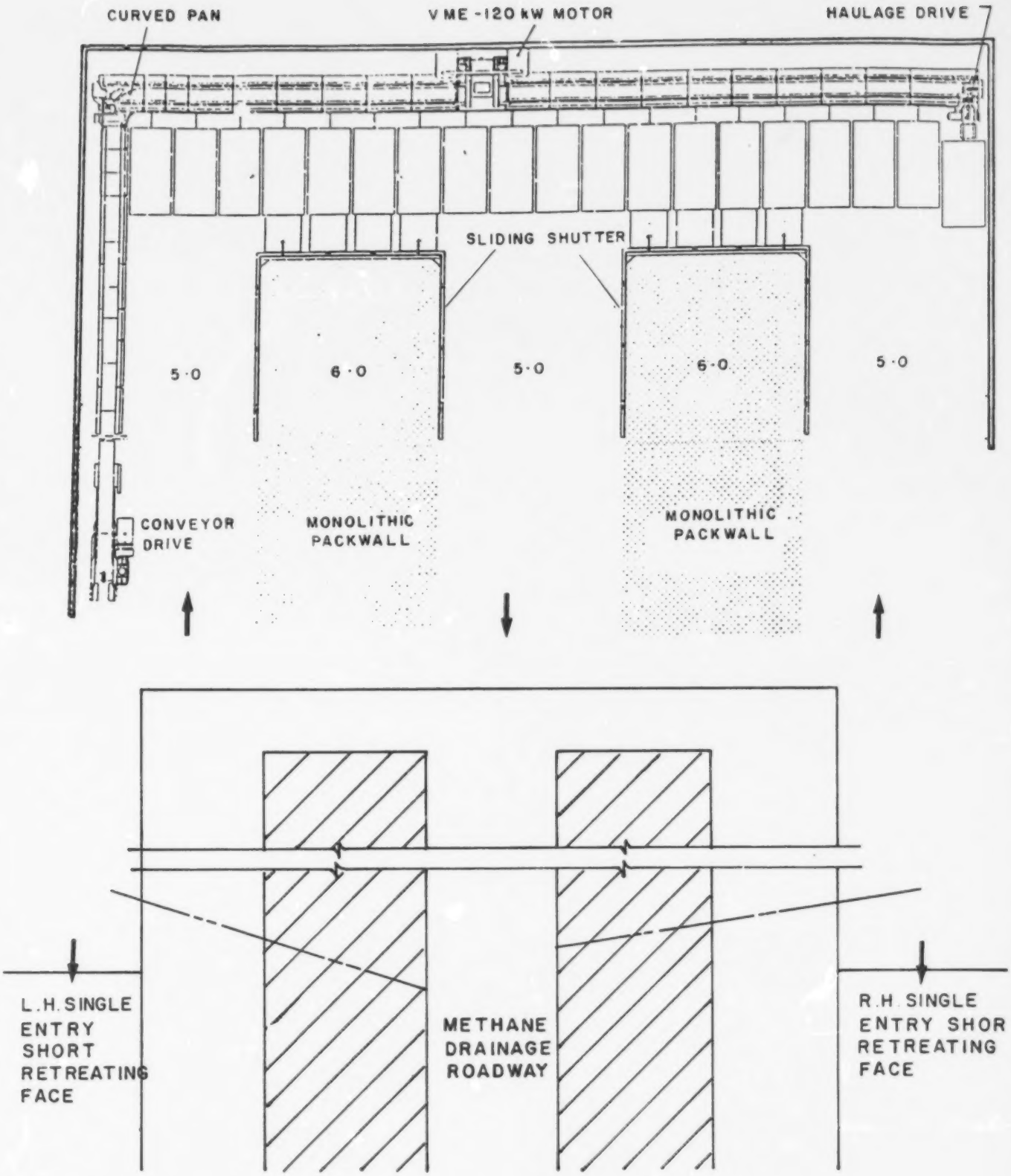


FIGURE 4-10

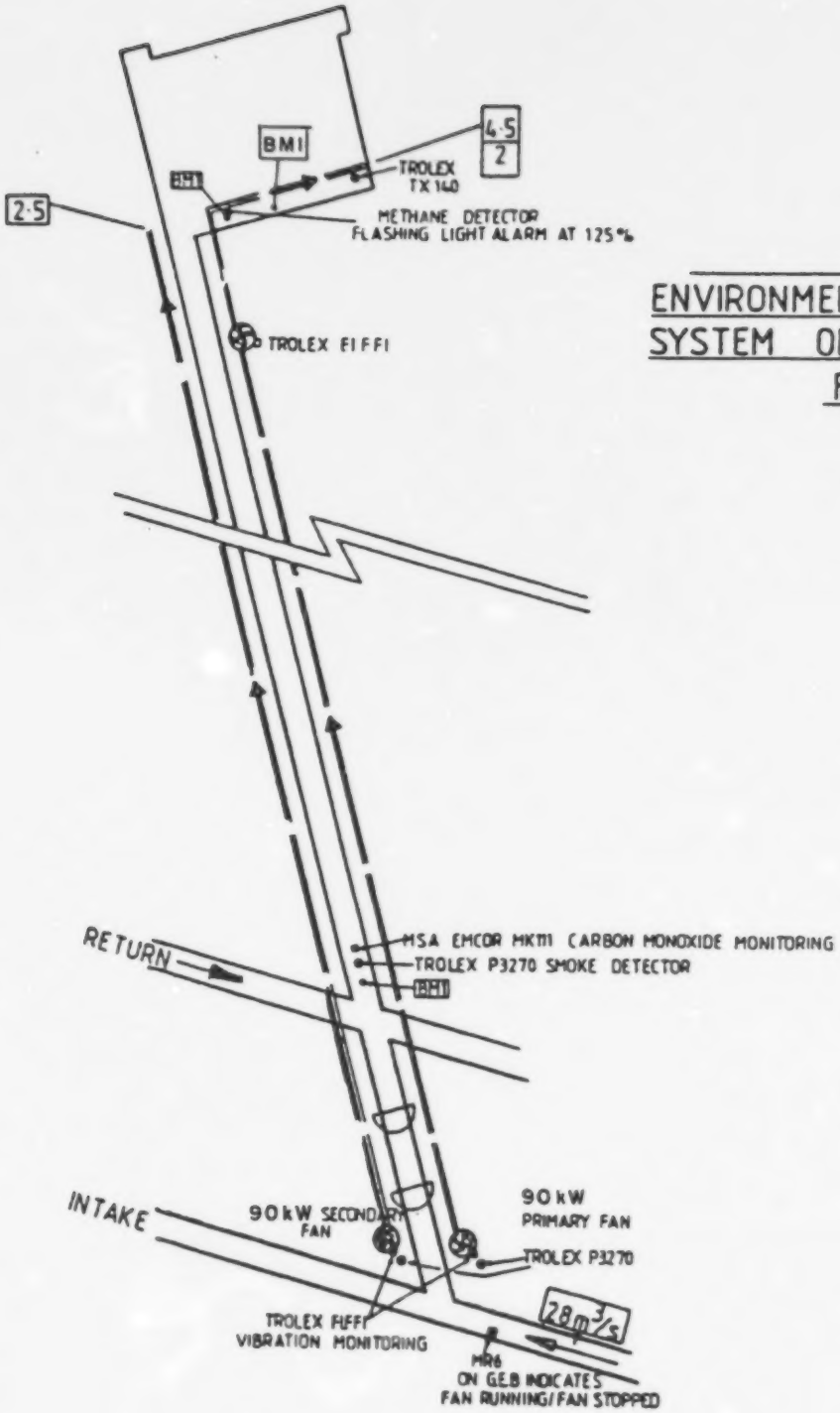
(Source: Ref.A7,A11)



SINGLE ENTRY DRAINGE FOR METHANE DRAINAGE

(Source: Westfalia)

FIGURE 4-11

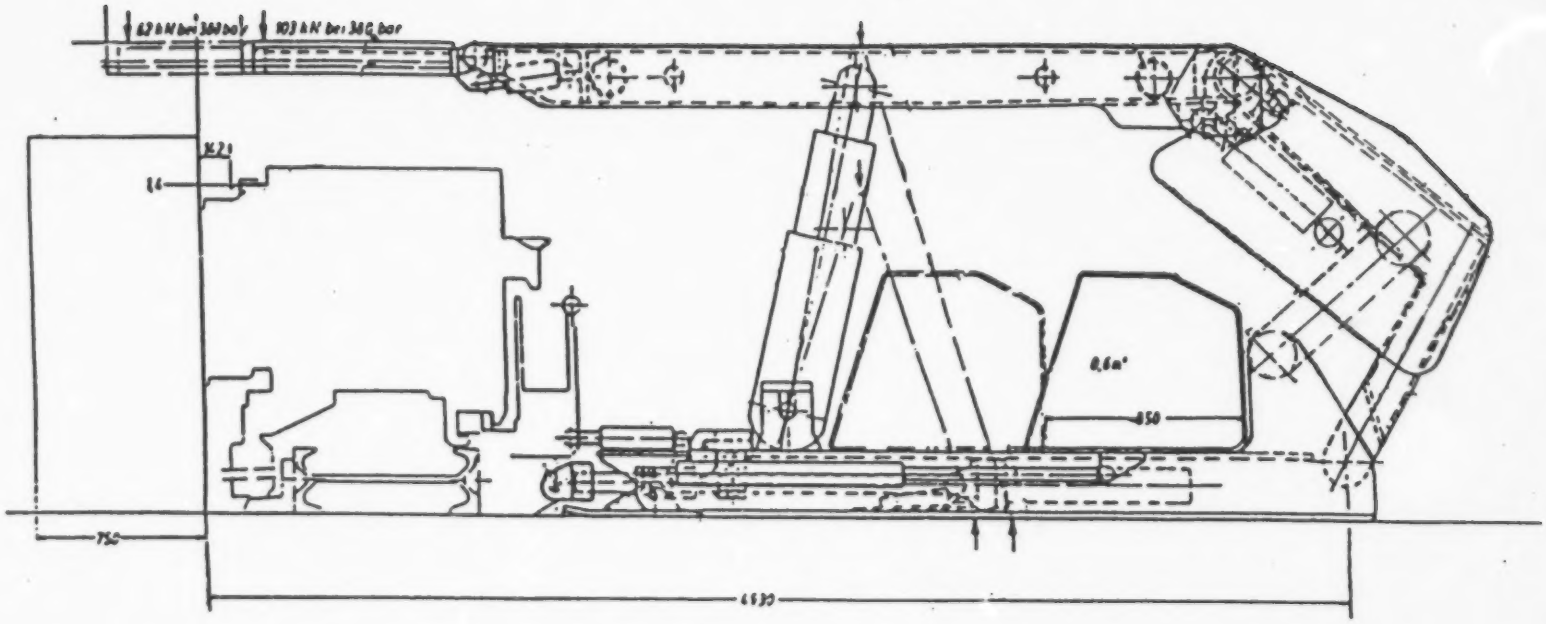


VENTILATION AND ENVIRONMENTAL MONITORING SYSTEM OF A SINGLE ENTRY FACE.

TYPICAL MONITORING PLAN

FIGURE 4-12

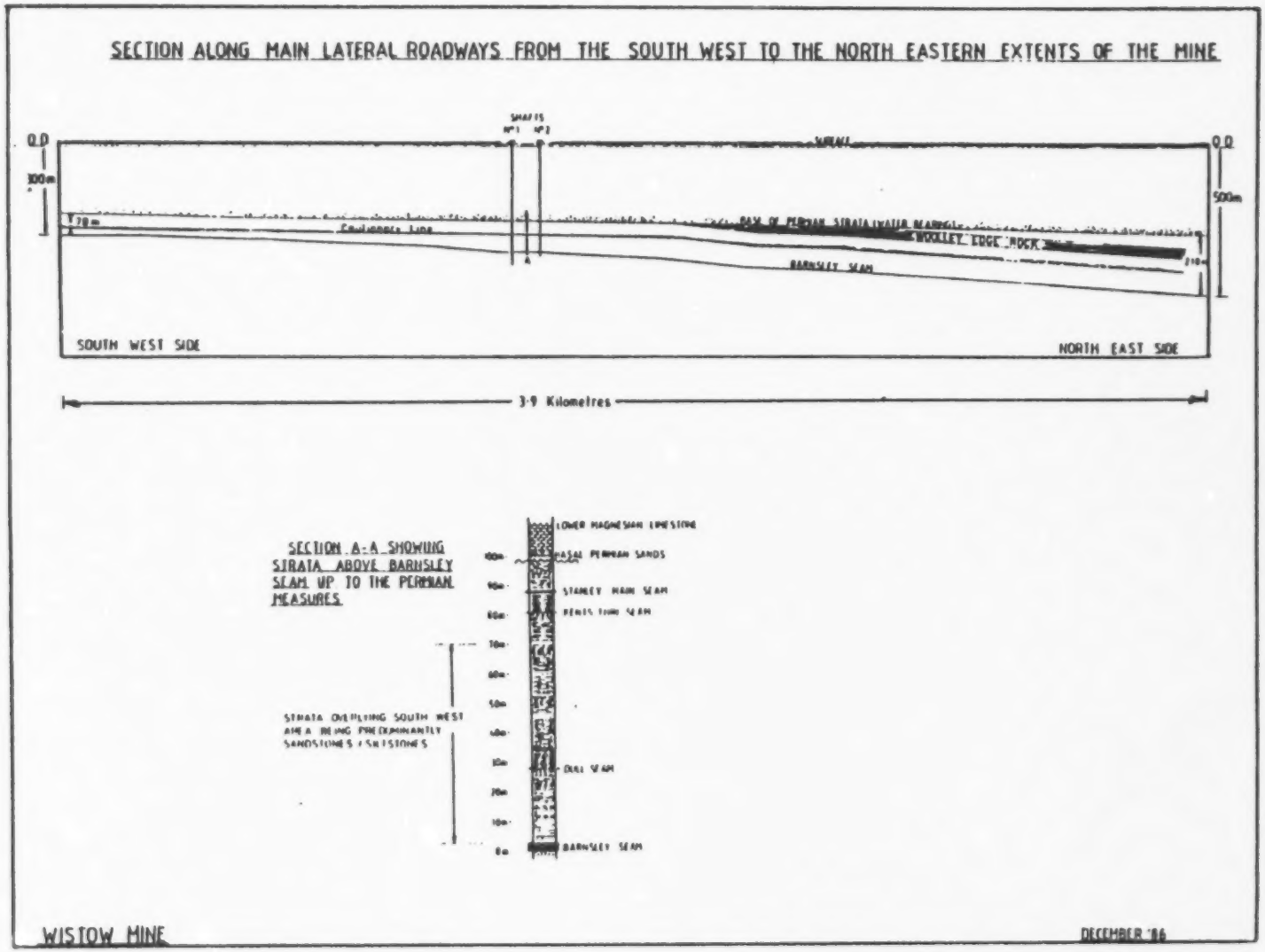
(Source: Ref.A3)



FACE EMERGENCY ESCAPE DUCT (Source: Ref.A16)

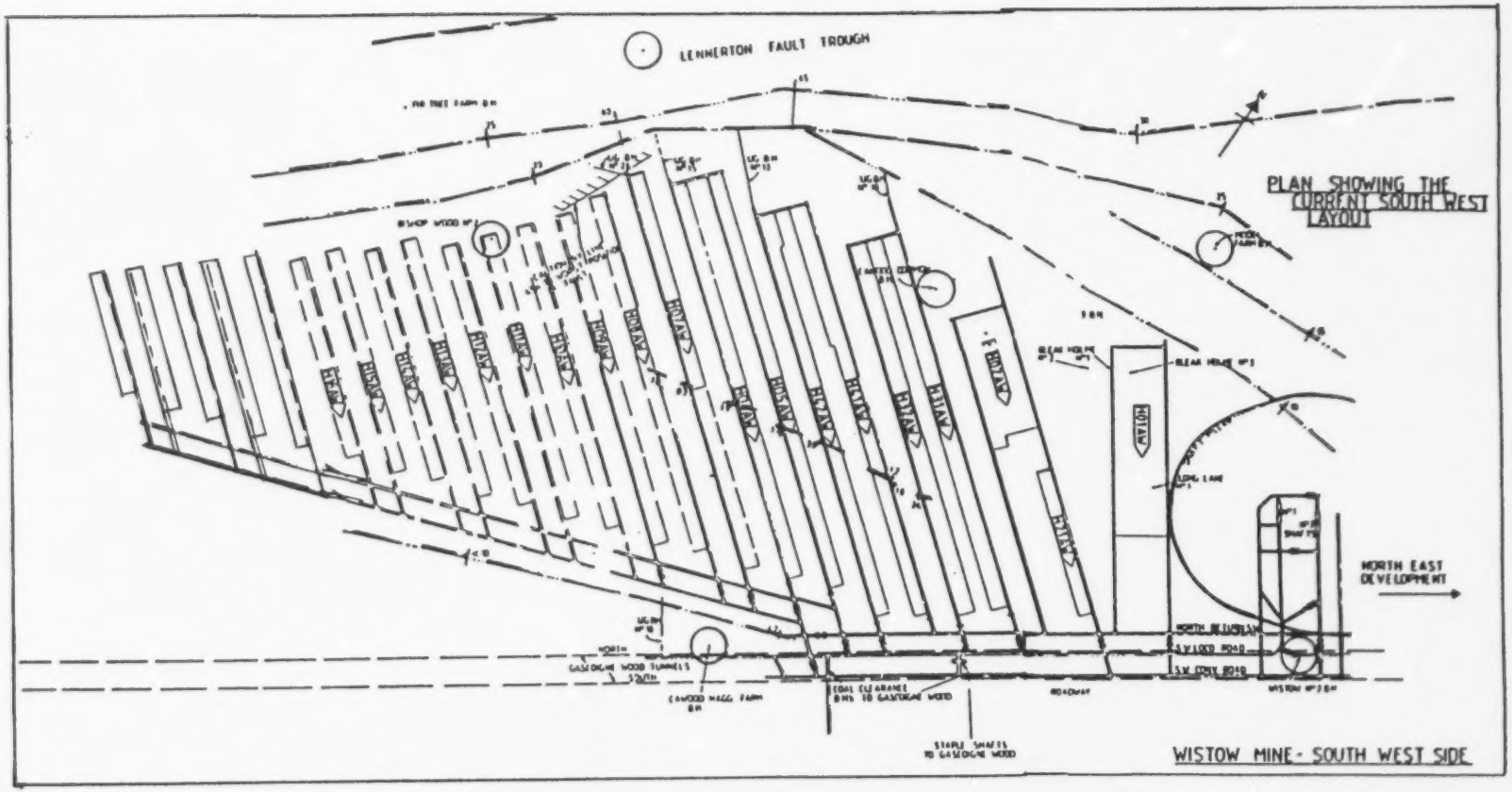
FIGURE 4-13

FIGURE 4 - 14



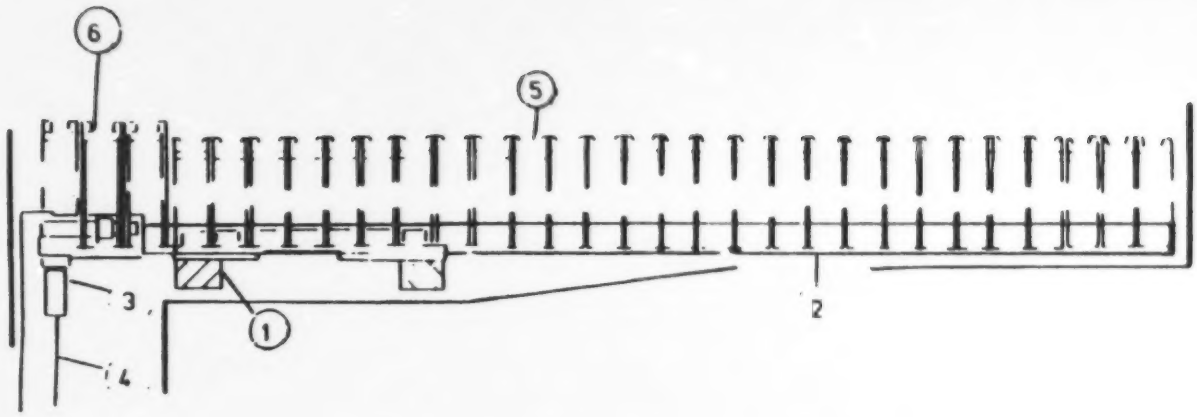
WISTOW MINE - GEOLOGY (Source: Ref.A3)

WISTOW MINE - SOUTH WEST SIDE
PLAN SHOWING PROPOSED WORKINGS



WISTOW MINE - PLAN, SW SIDE

(Source: Ref.A3)

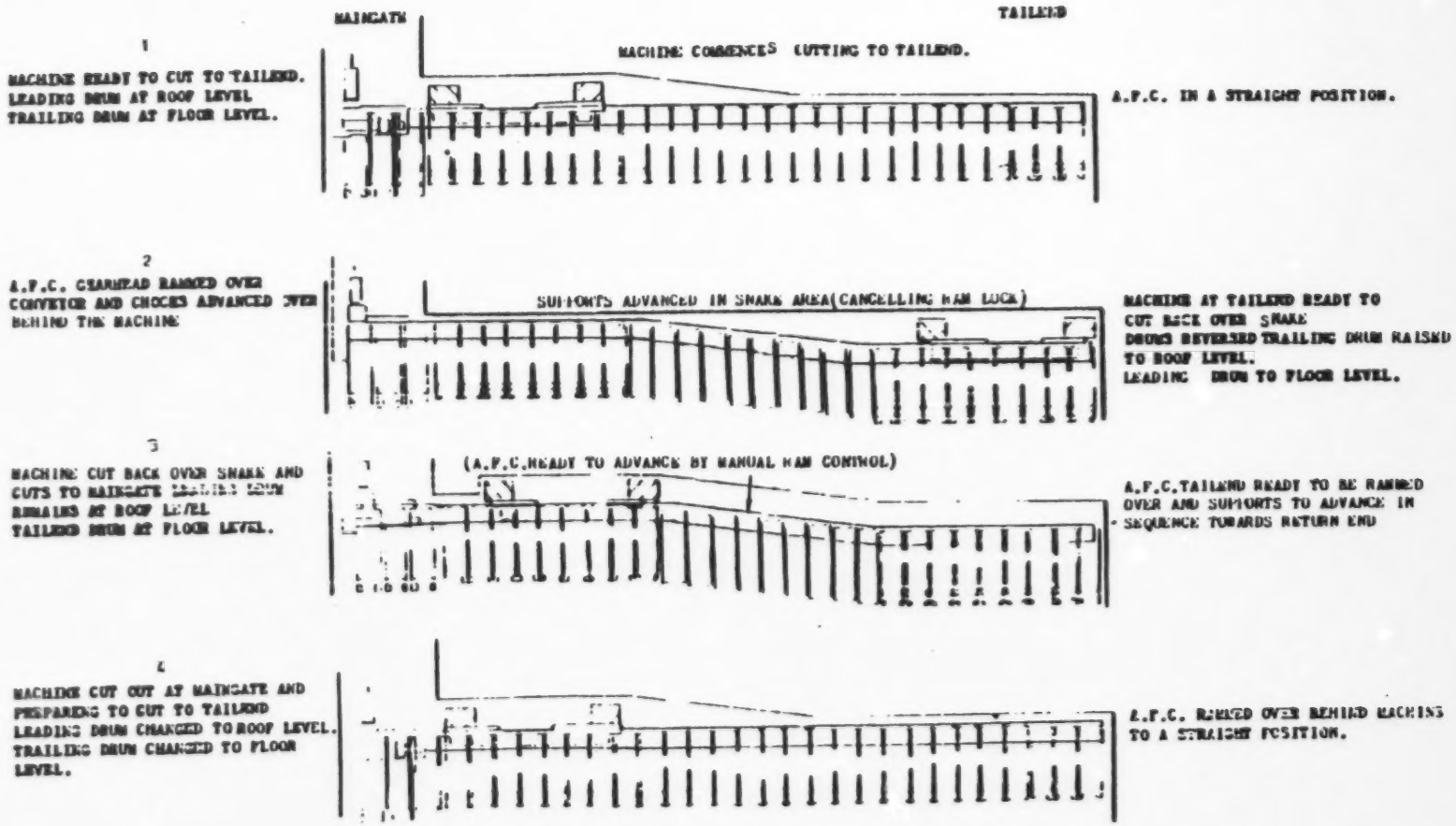


ITEM	DESCRIPTION	QUANTITY
1	AM 500 DERDS Power Loader	1
2	222mm X 664mm HD AFC	1
3	112kW Electric Motor	1
4	Beam Stage Loader	1
5	Dowty 4/650 Chock Shields	27
6	Dowty 4/280 Anchors	3

WISTOW MINE-FACE ARRANGEMENT

FIGURE 4-16

(Source: Ref.A2)

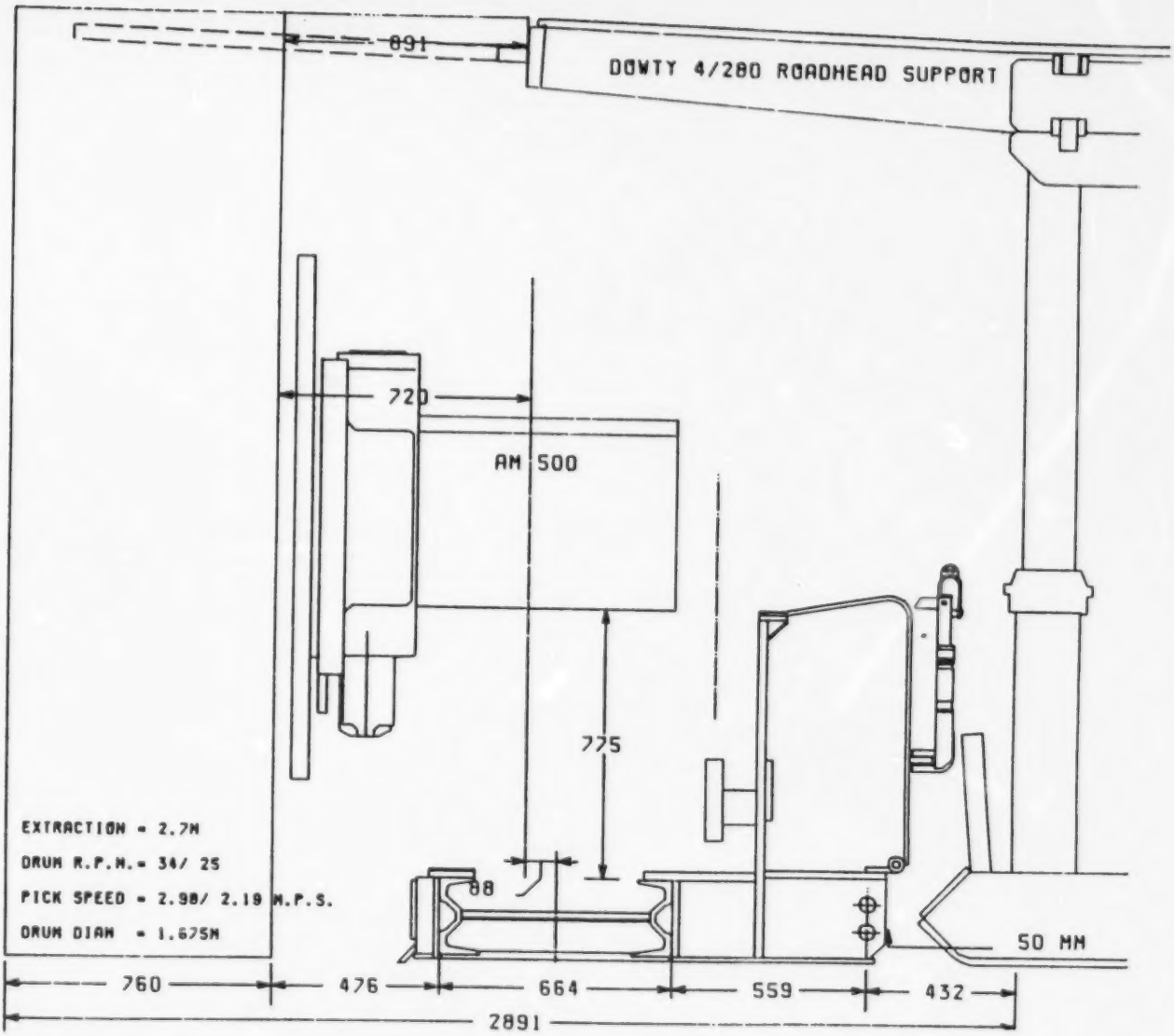


MANPOWER OPERATIONS
2 MACHINE OPERATORS. 1SUPPORT OPERATOR.
SUPPORT OPERATOR INITIATES PRIME FROM MAINGATE
END AND ADVANCES CONVEYOR AND SUPPORTS SEQUENTIAL
TO RETURN END

WISTOW MINE - FACE SEQUENCE

(Source: Ref.A2)

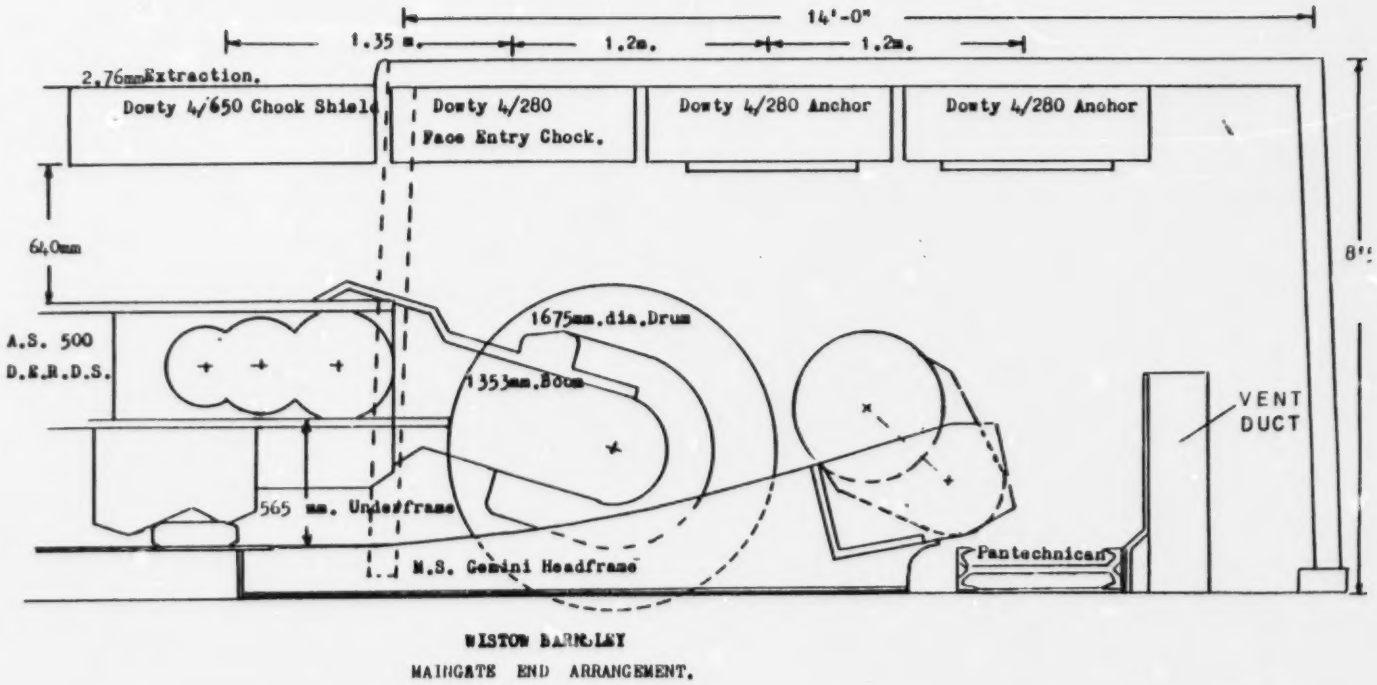
FIGURE 4-17



WISTOW MINE - FACE SECTION

FIGURE 4-18

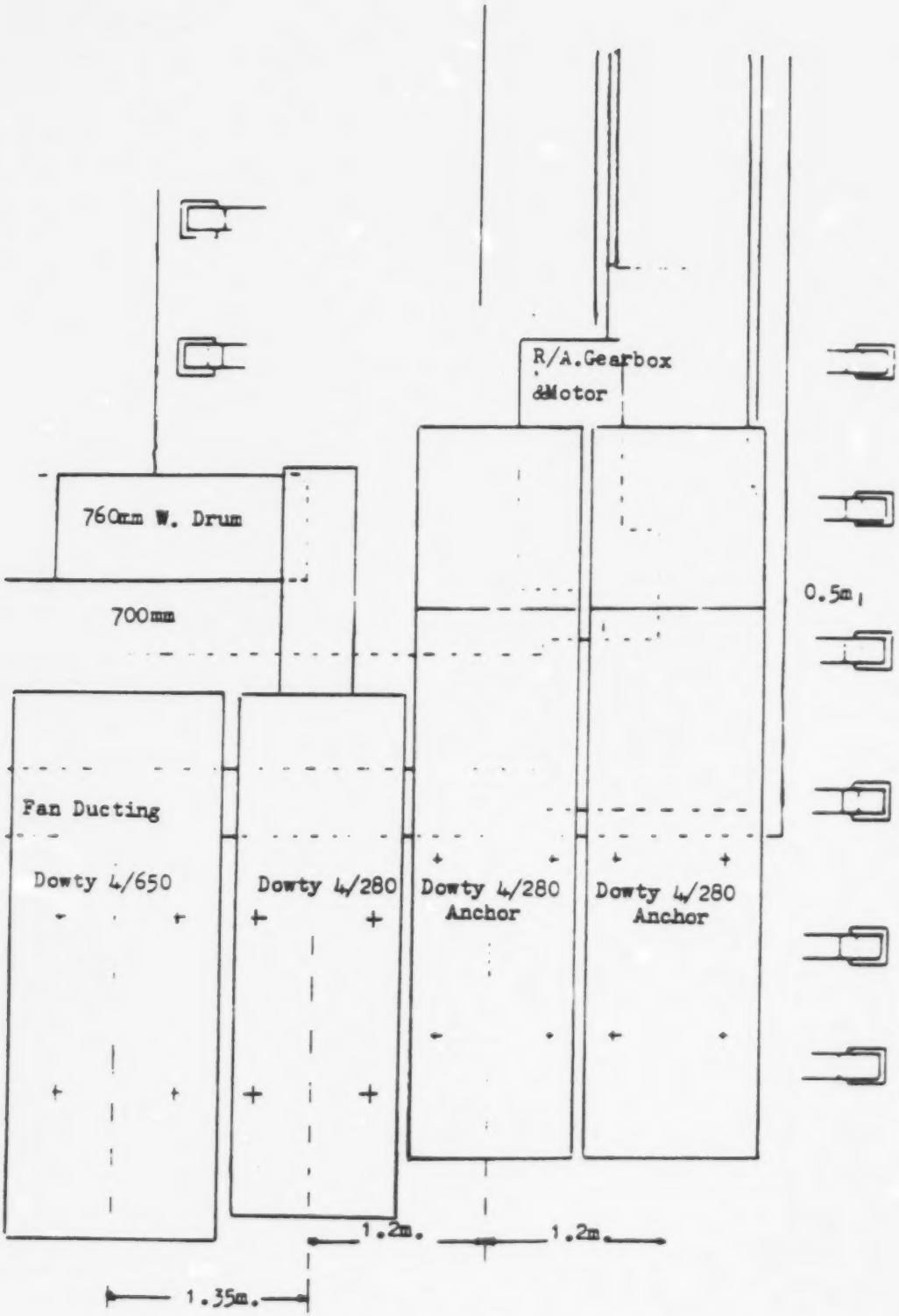
(Source: Ref.A2)



WISTOW MINE - MAIN GATE END

(Source: Ref.A2)

FIGURE 4 - 19

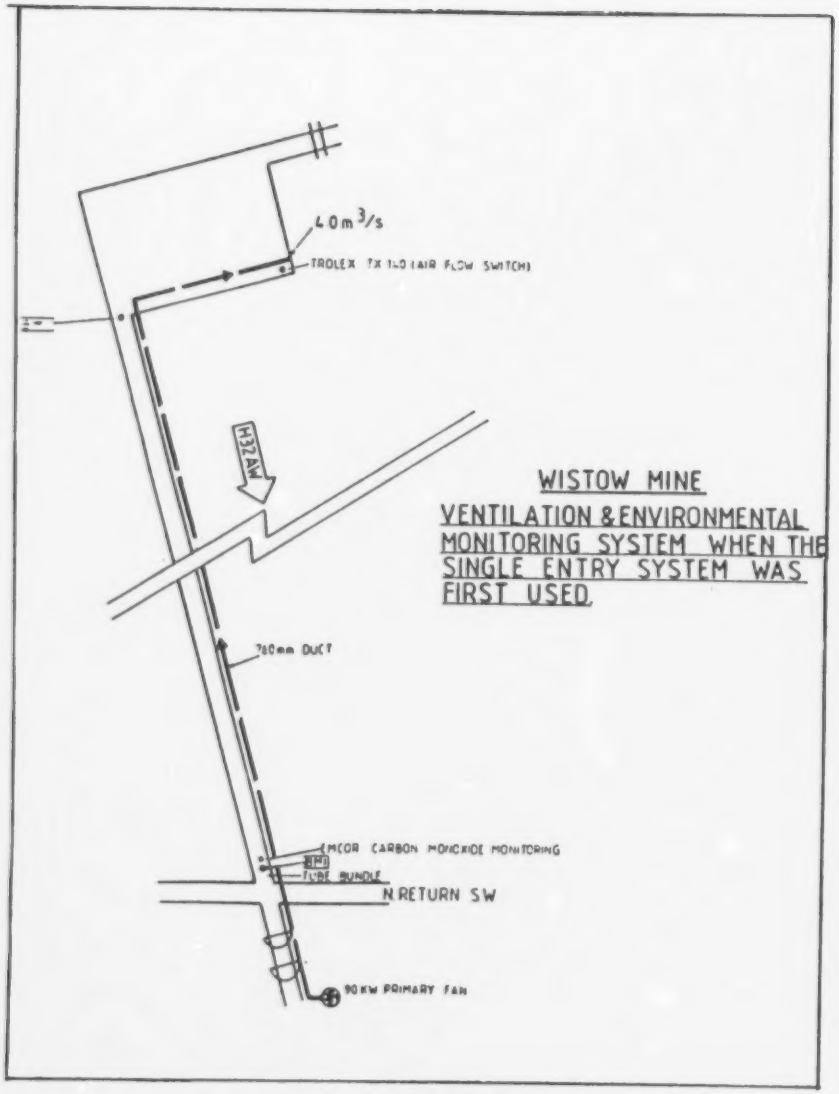


WISTOW-BARNSLEY WA42s. (Single Entry)
Main Gate Support System

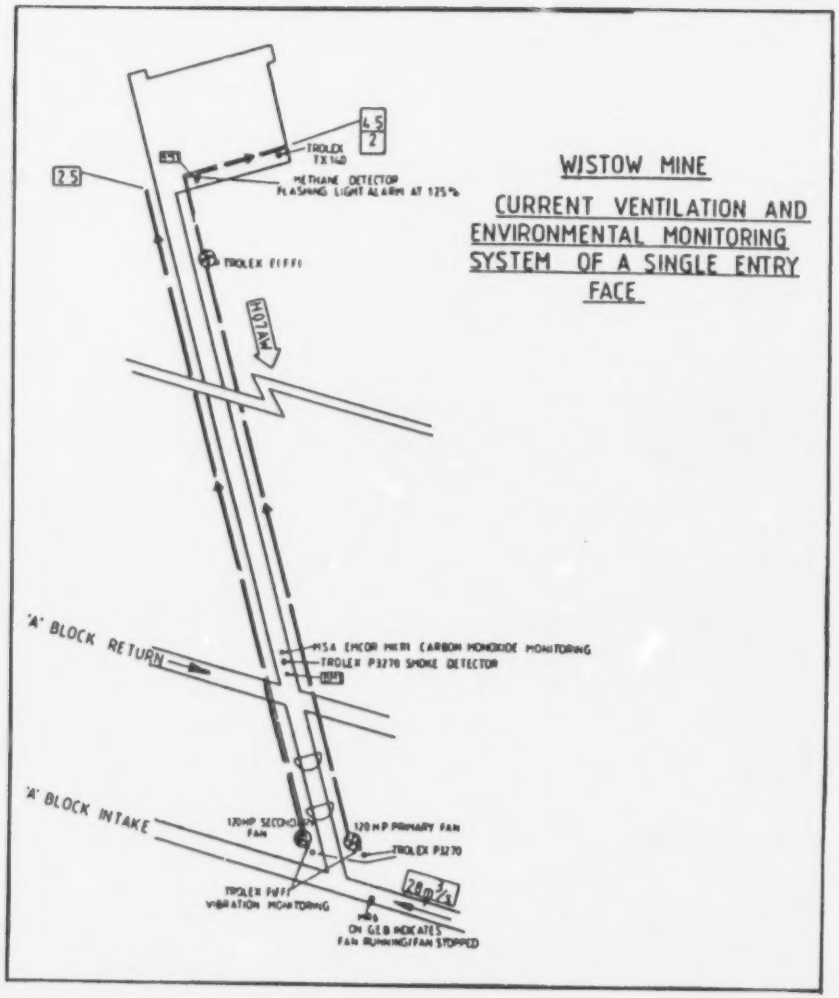
WISTOW MINE - MAIN GATE SUPPORT

FIGURE 4-20

(Source: Ref.A2)



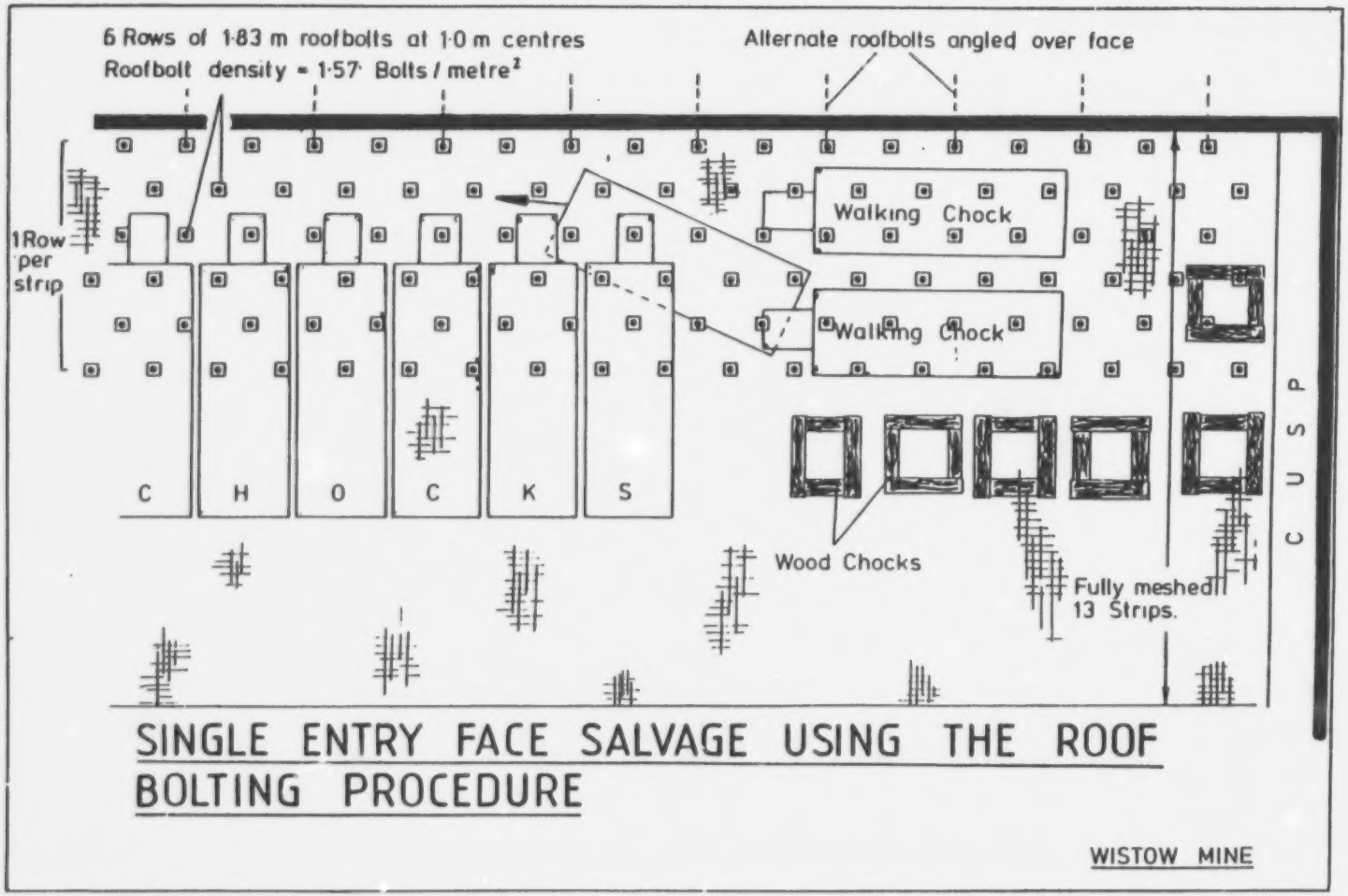
4 - 21(b)



4 - 21 (a)

WISTOW MINE - EARLY & CURRENT VENTILATION SYSTEMS (Source: Ref.A3)

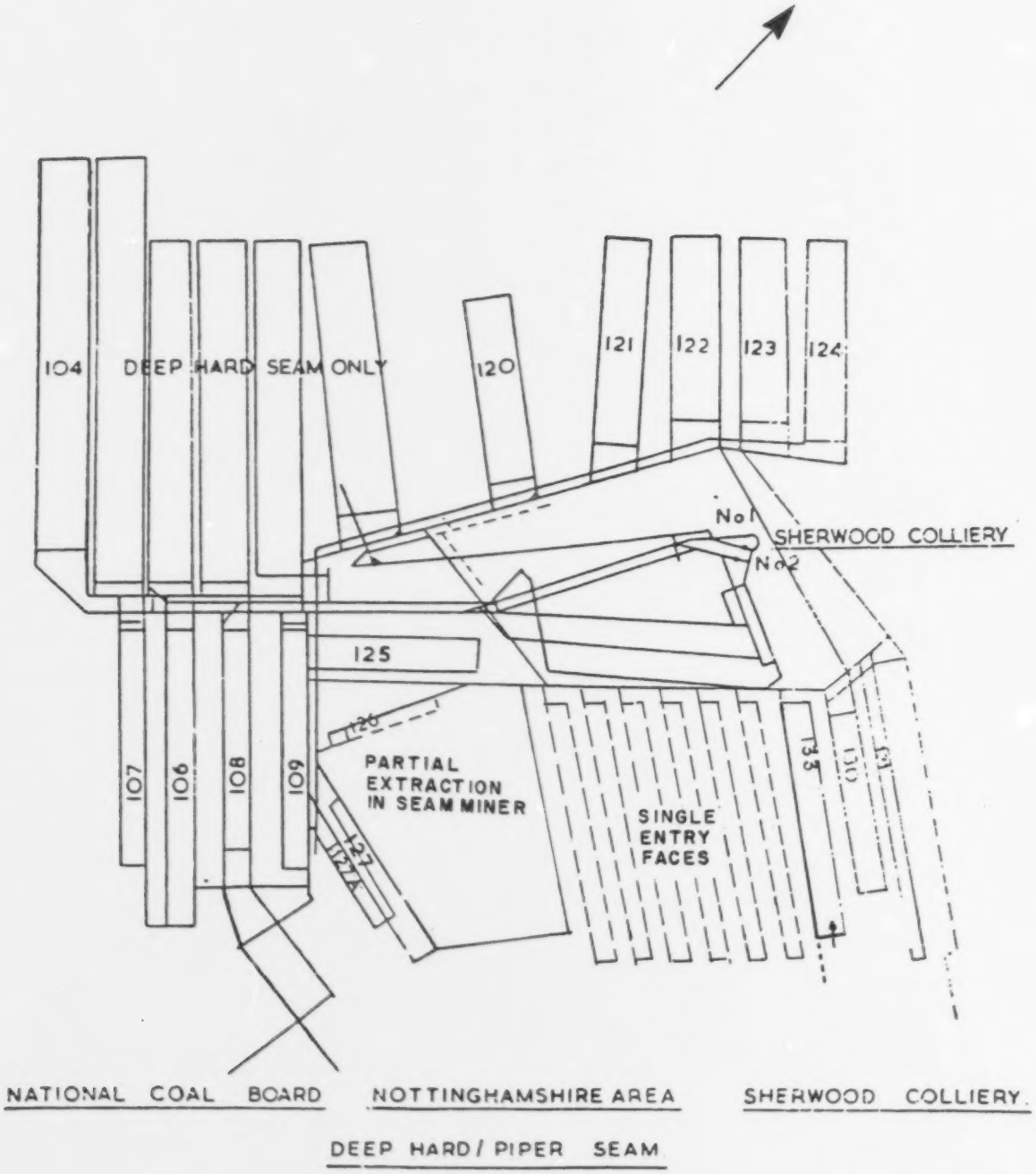
FIGURE 4-21



WISTOW MINE - CHOCK SALVAGE

(Source: Ref.A3)

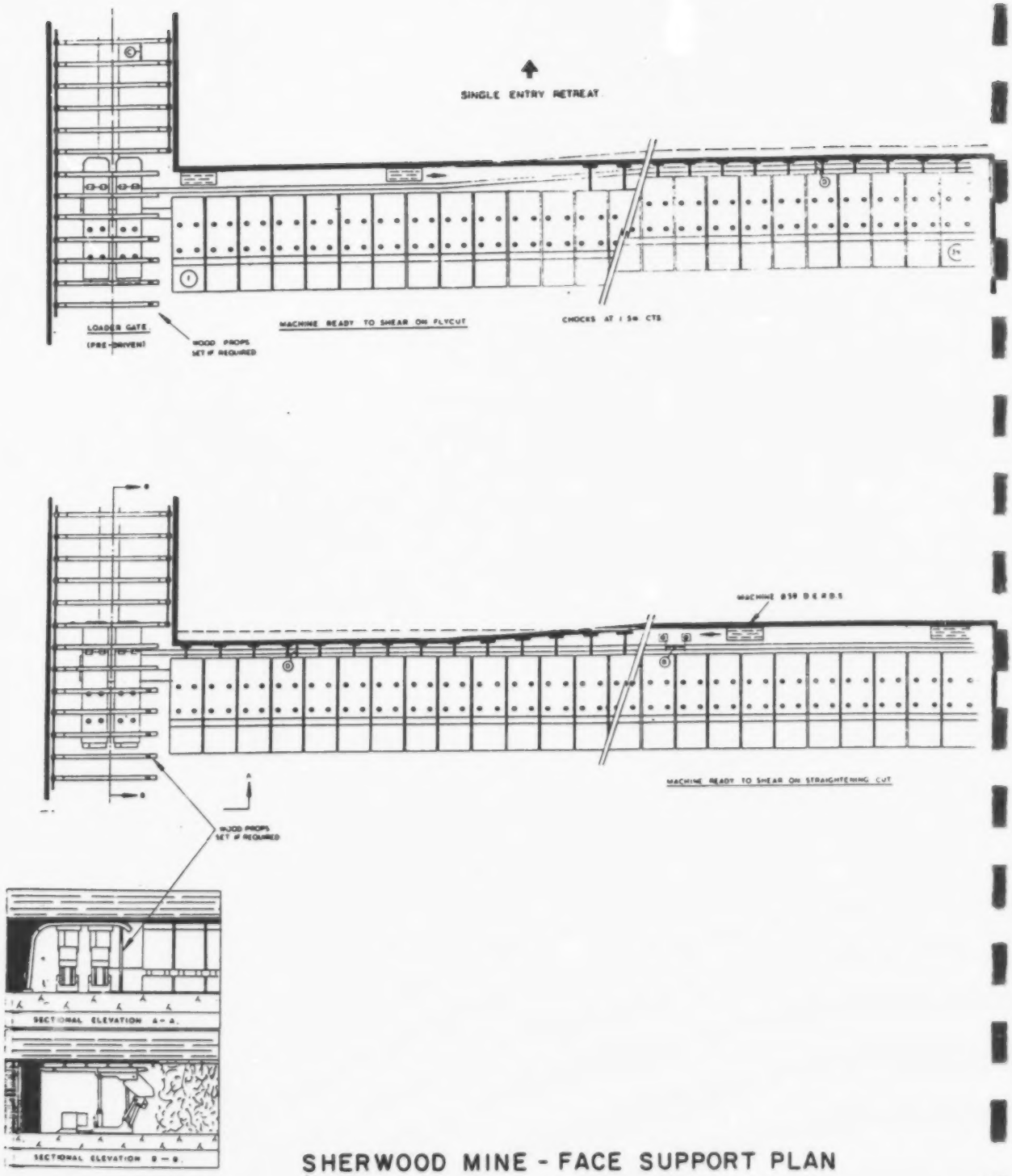
FIGURE 4-22



SHERWOOD MINE - PLAN

(Source: Ref.A6)

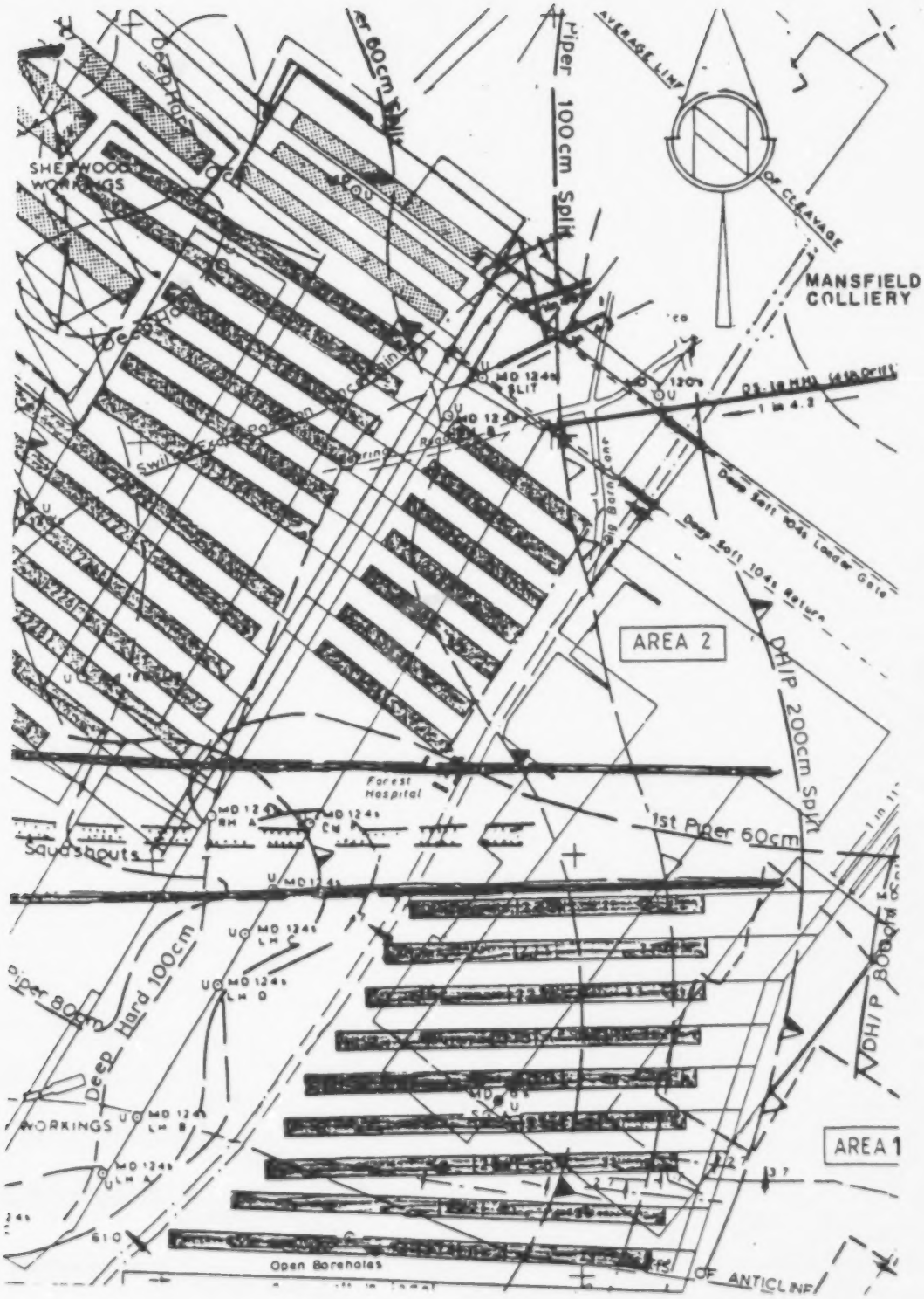
FIGURE 4-23



SHERWOOD MINE - FACE SUPPORT PLAN

FIGURE 4-24

(Source: Ref.A4)



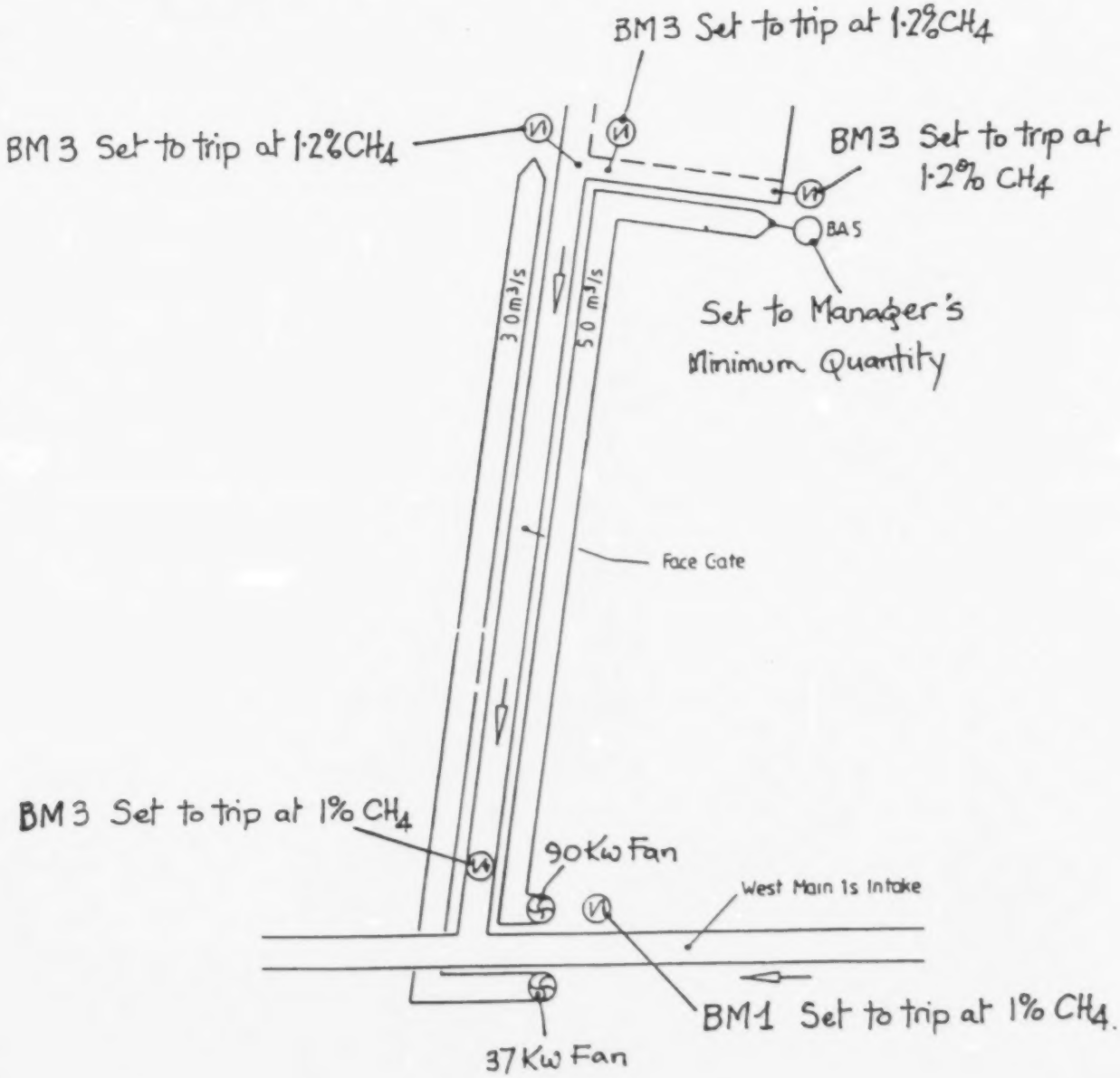
MANSFIELD MINE - PLAN - SINGLE ENTRY FACES

(Source: Ref.A6)

FIGURE 4-25

Mansfield Colliery – Deep Hard / Piper Seam.

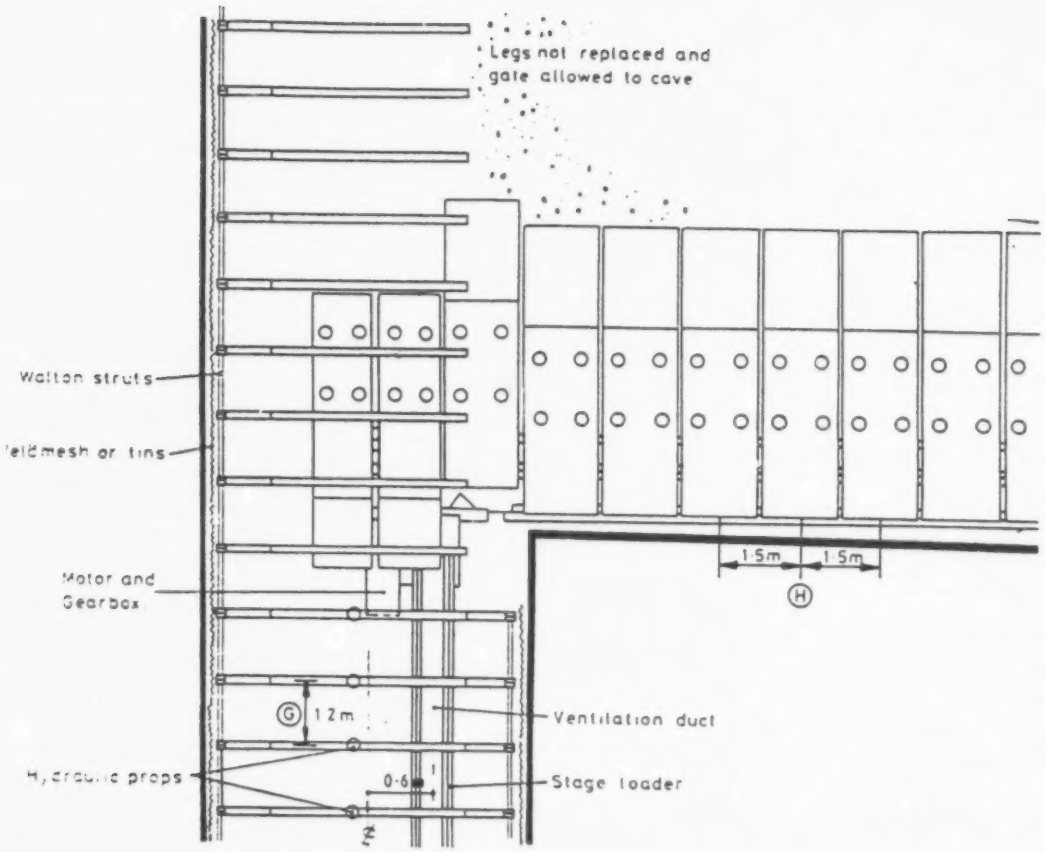
Typical Methane & Air Protection Positions for Single Entry Face.

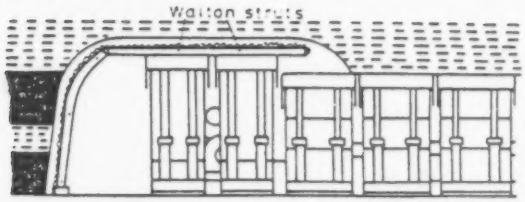


MANSFIELD MINE - VENTILATION PLAN

FIGURE 4 - 26

(Source: Ref.A6)





Section

204s Face – 'T' Junction

MANSFIELD MINE - ROADHEAD SUPPORT

(Source: Ref.A5)

FIGURE 4-27

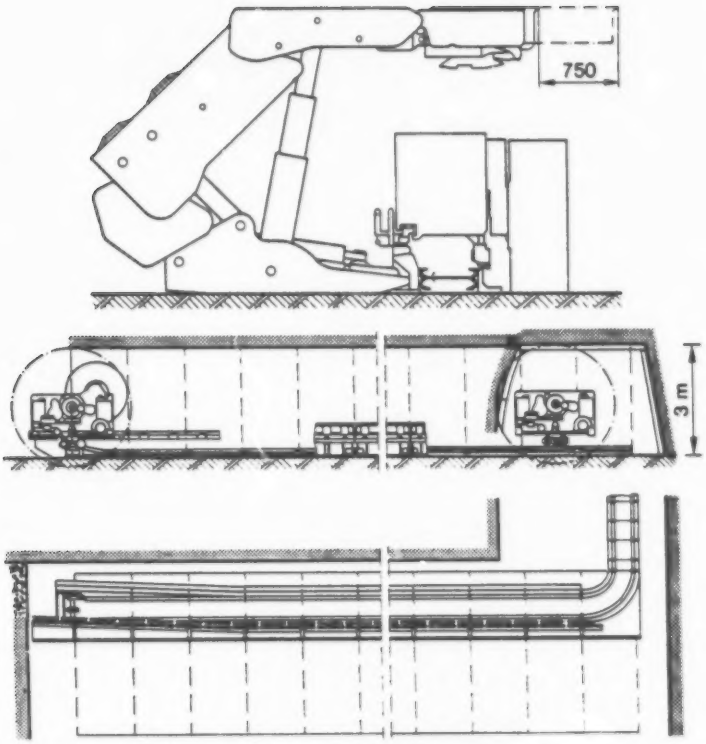


Fig. 3. The standard shield (top) and the shortwall face equipment (bottom).

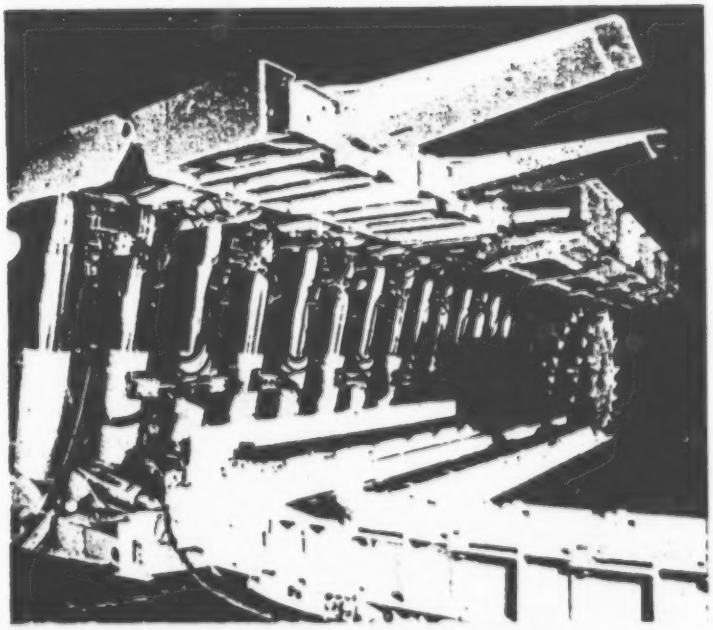
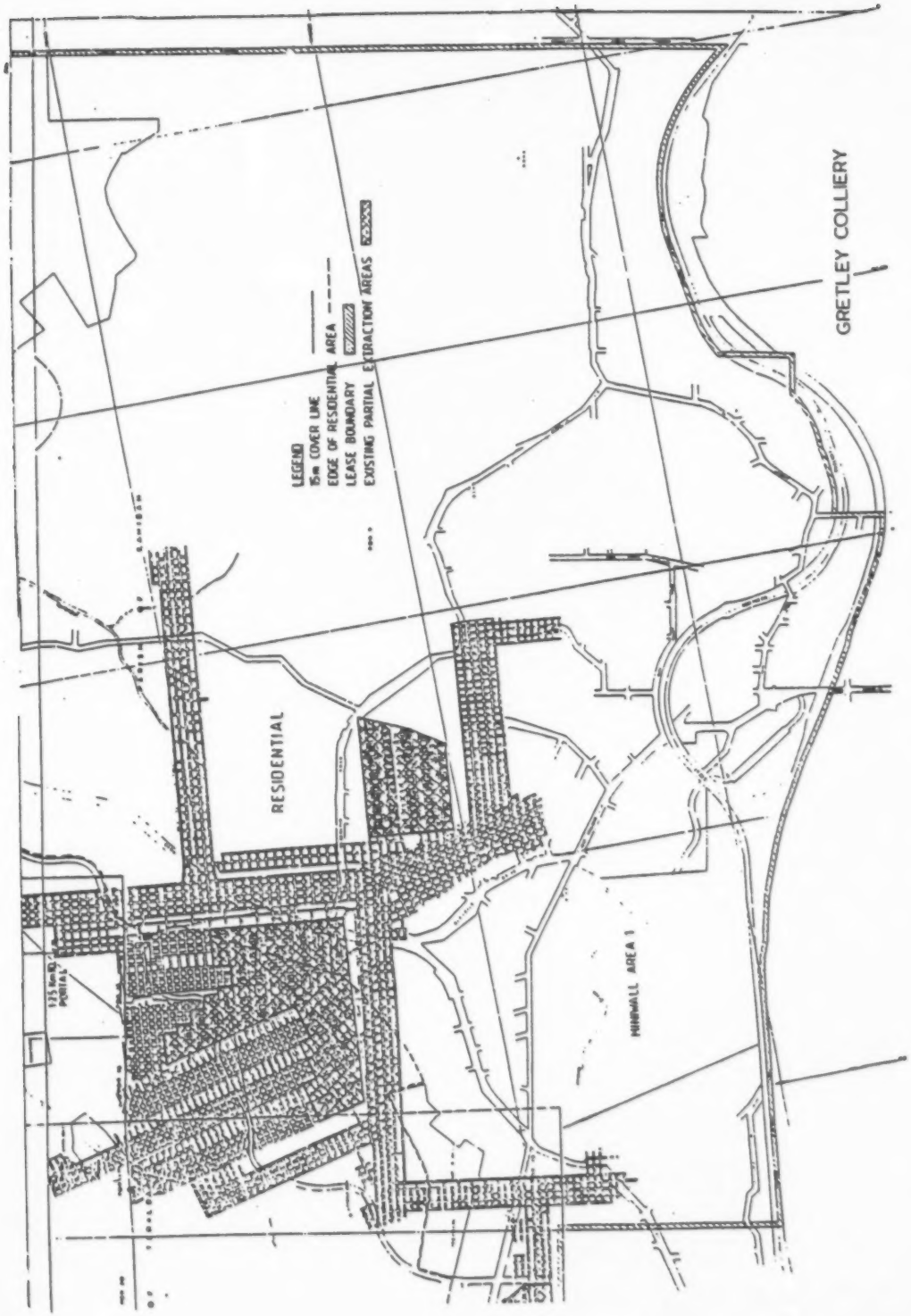


Fig. 4. View into the face from the face end.

STOLZENBACH MINE - FACE LAYOUT

FIGURE 4-28

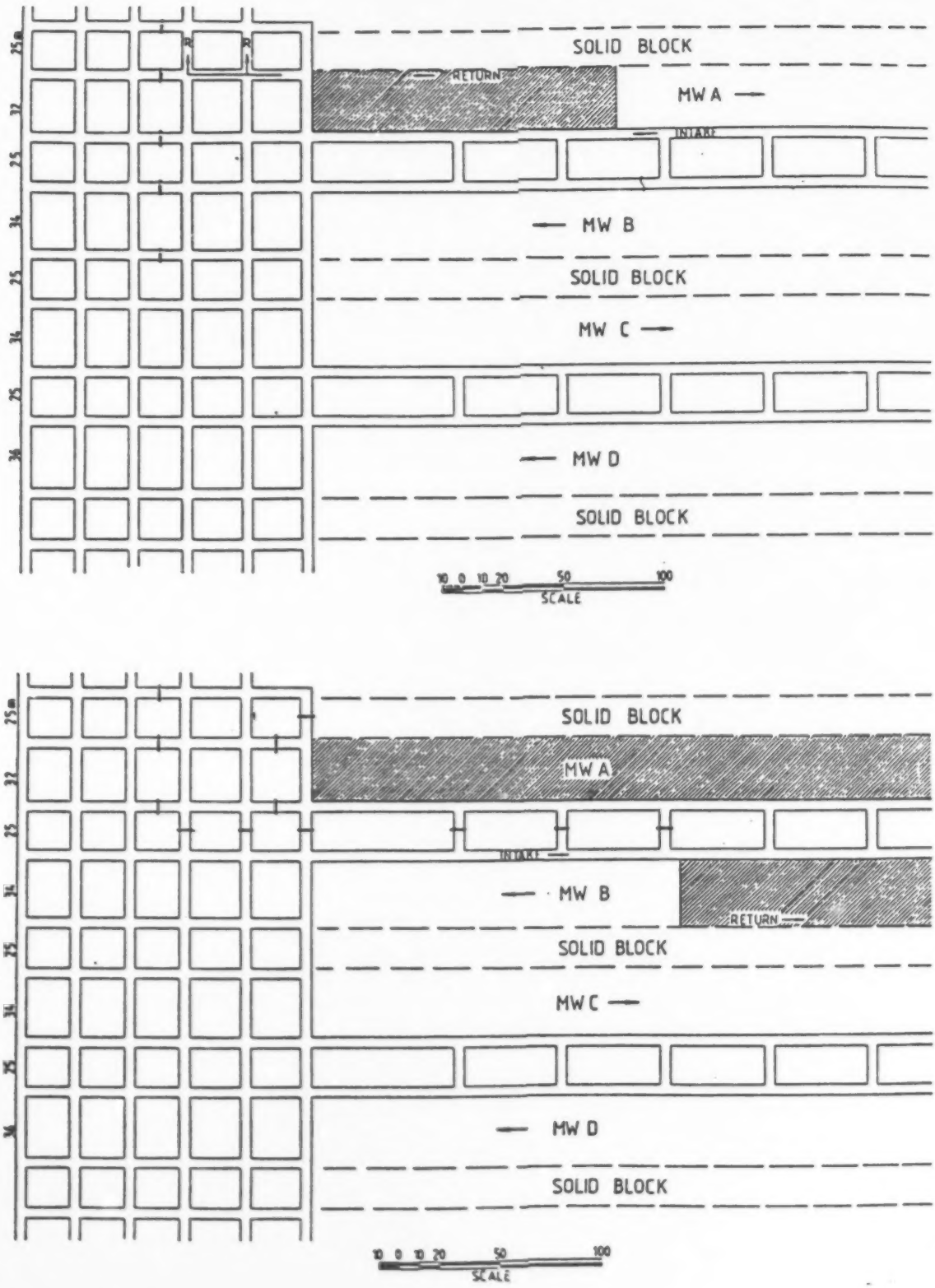
(Source: Ref.A14)



(Source: Ref.A12)

GRETLEY MINE - PLAN

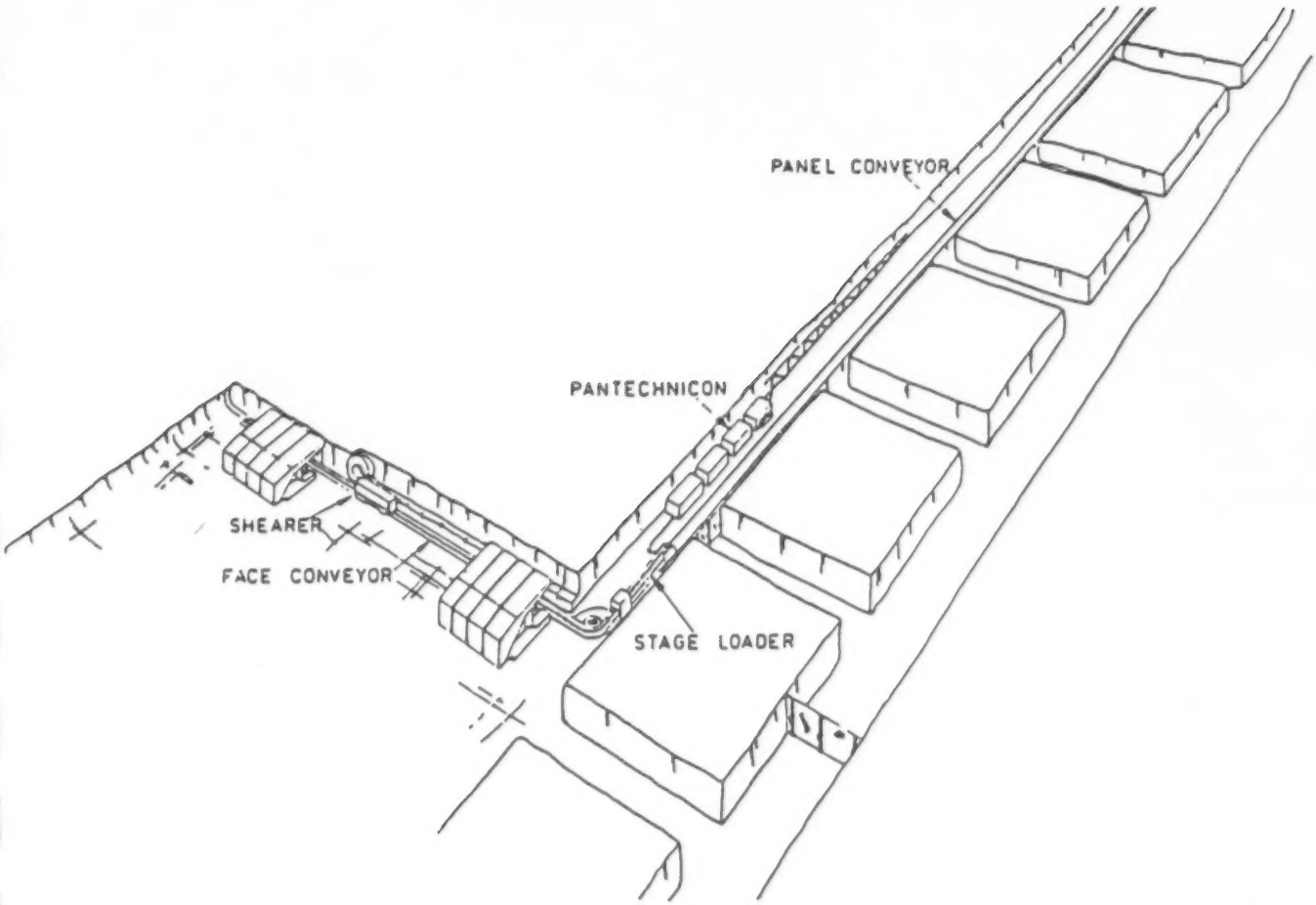
FIGURE 4-29



GRETLEY MINE - MINIWALL PANELS

FIGURE 4-30

(Source: Ref.A12)

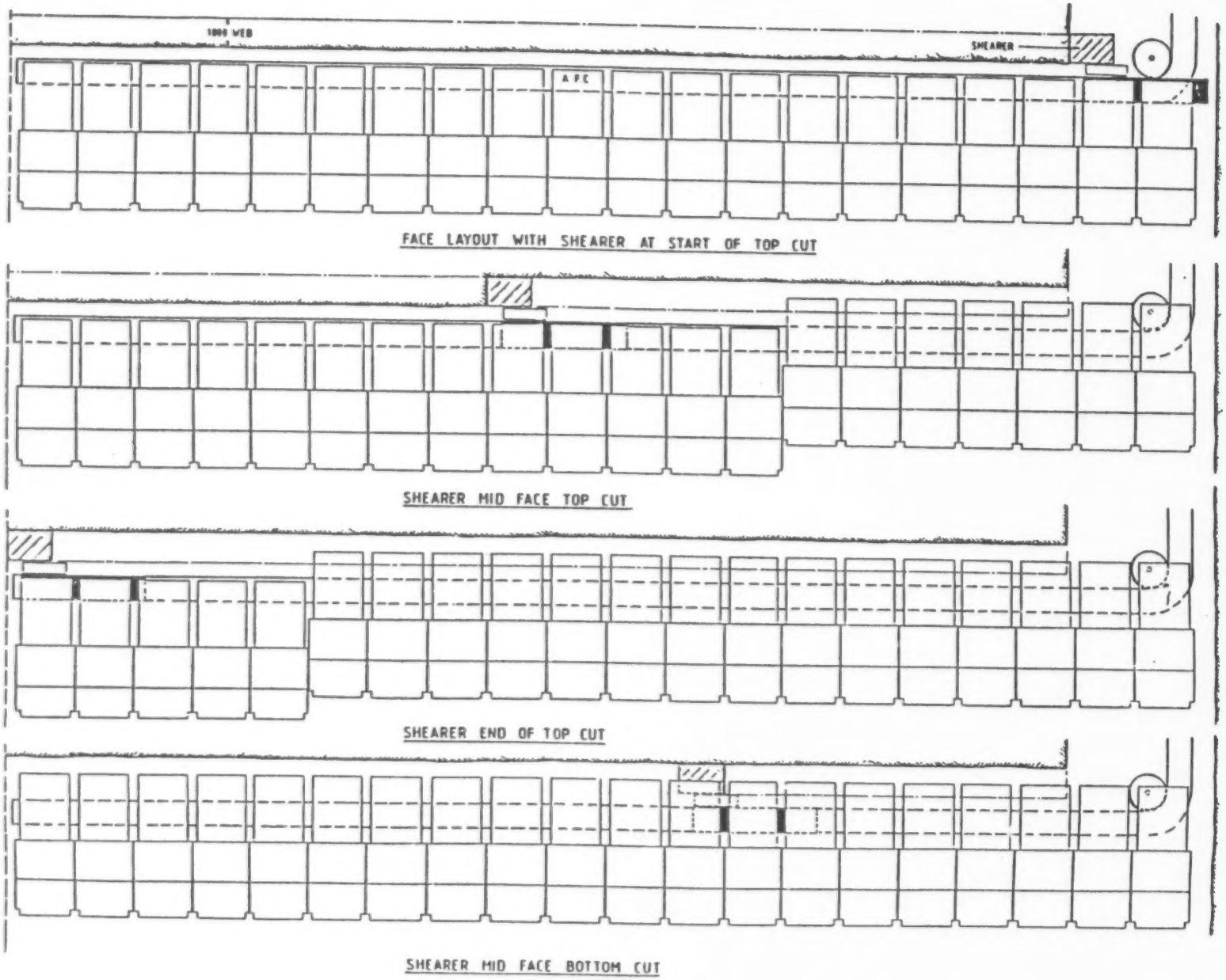


MINIWALL MINING SYSTEM

GRETLEY MINE - MINIWALL SCHEMATIC

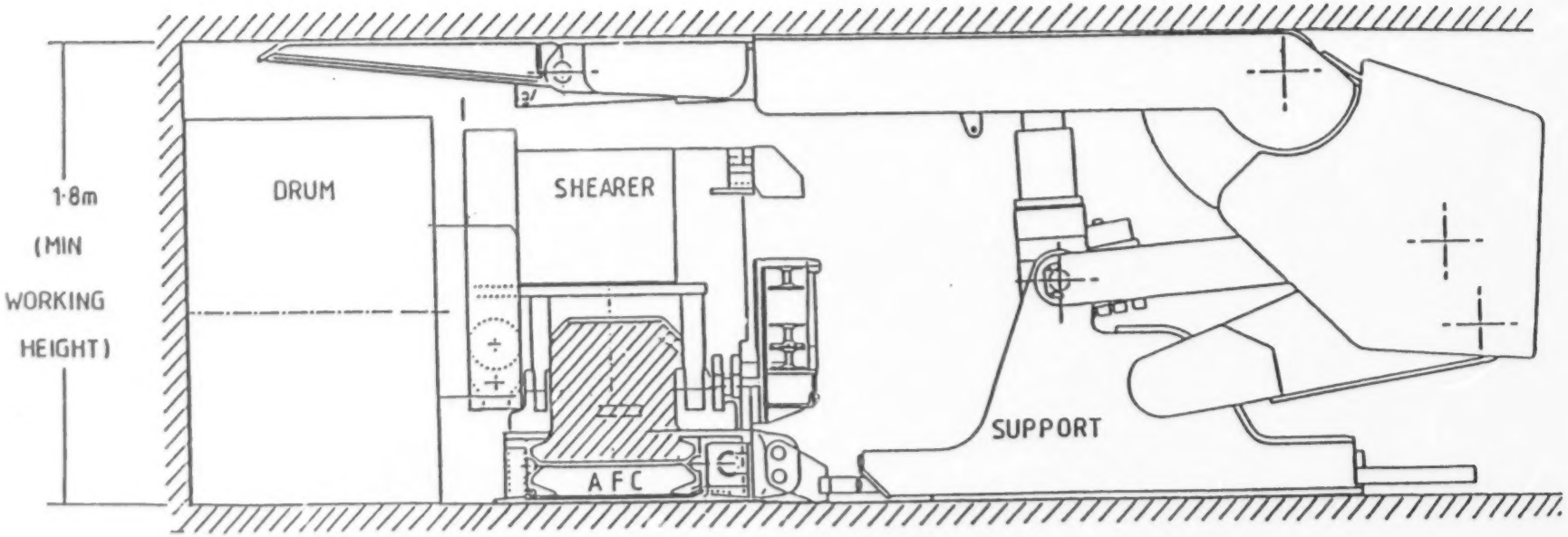
(Source: Ref.A12)

FIGURE 4-31



GRETLEY MINE - CUTTING SEQUENCE (Source: Ref.A12)

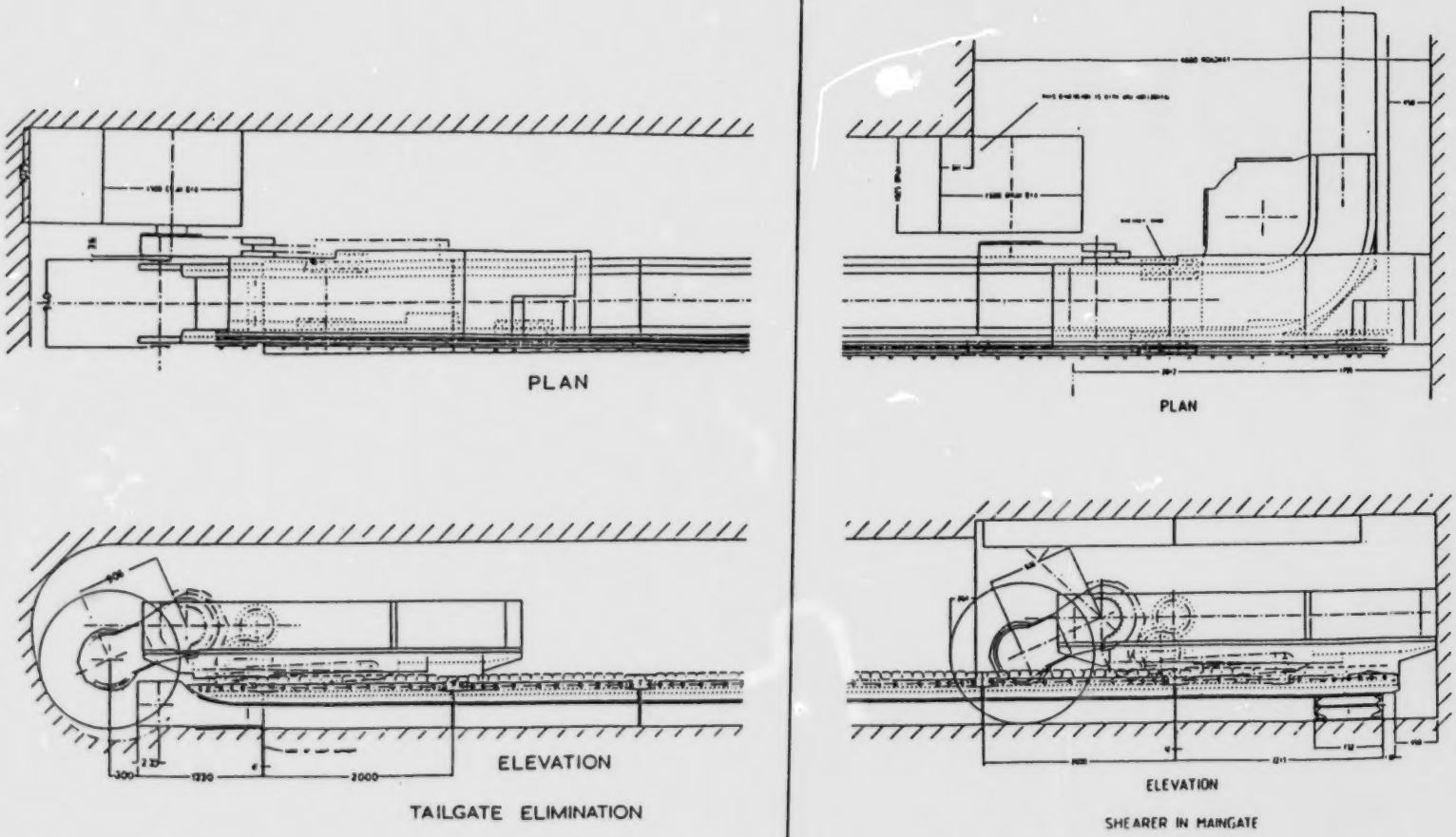
FIGURE 4-32



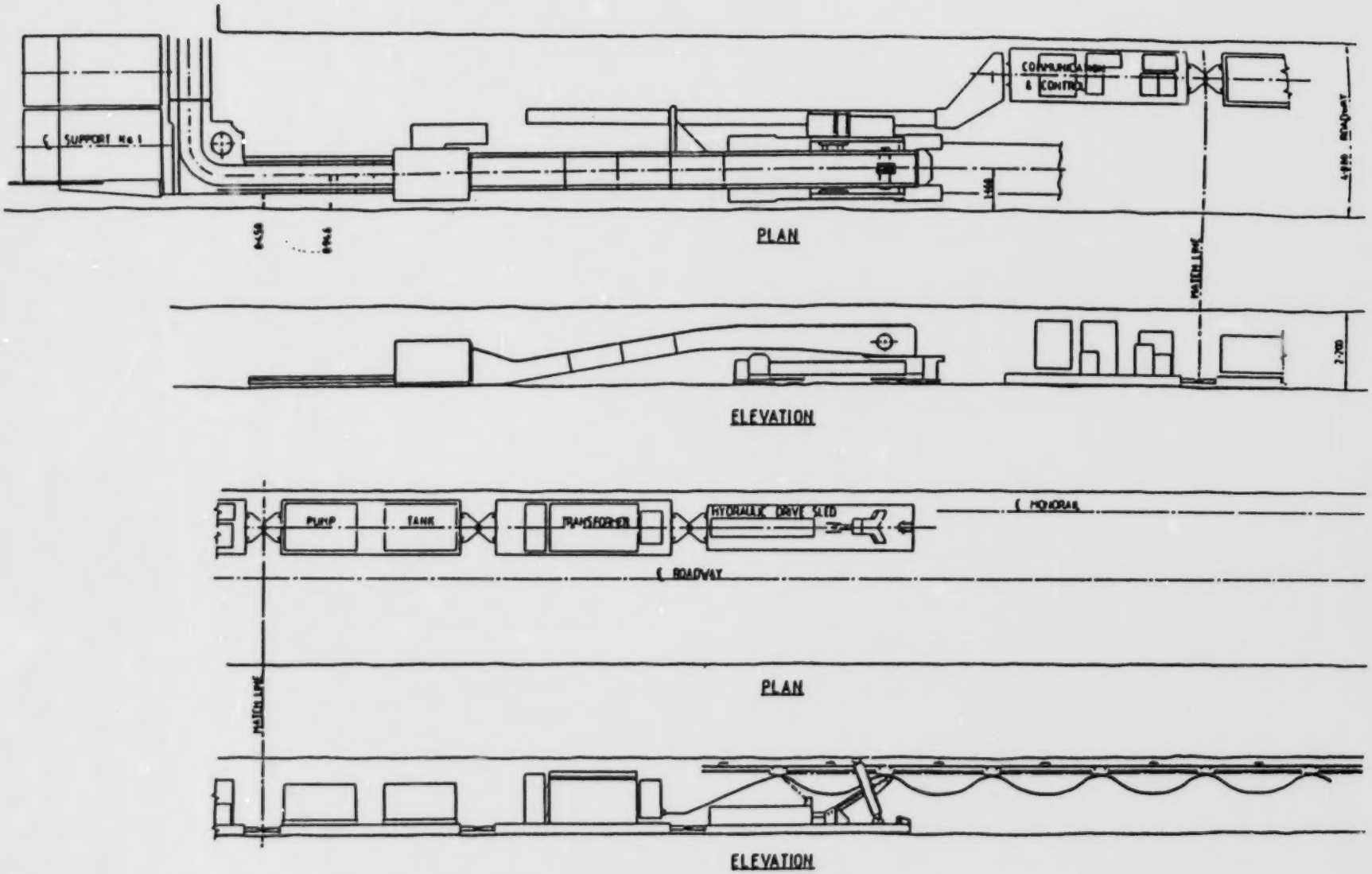
GRETLEY MINE - FACE CROSS SECTION (Source: Ref.A12)

FIGURE 4-33

FIGURE 4-34

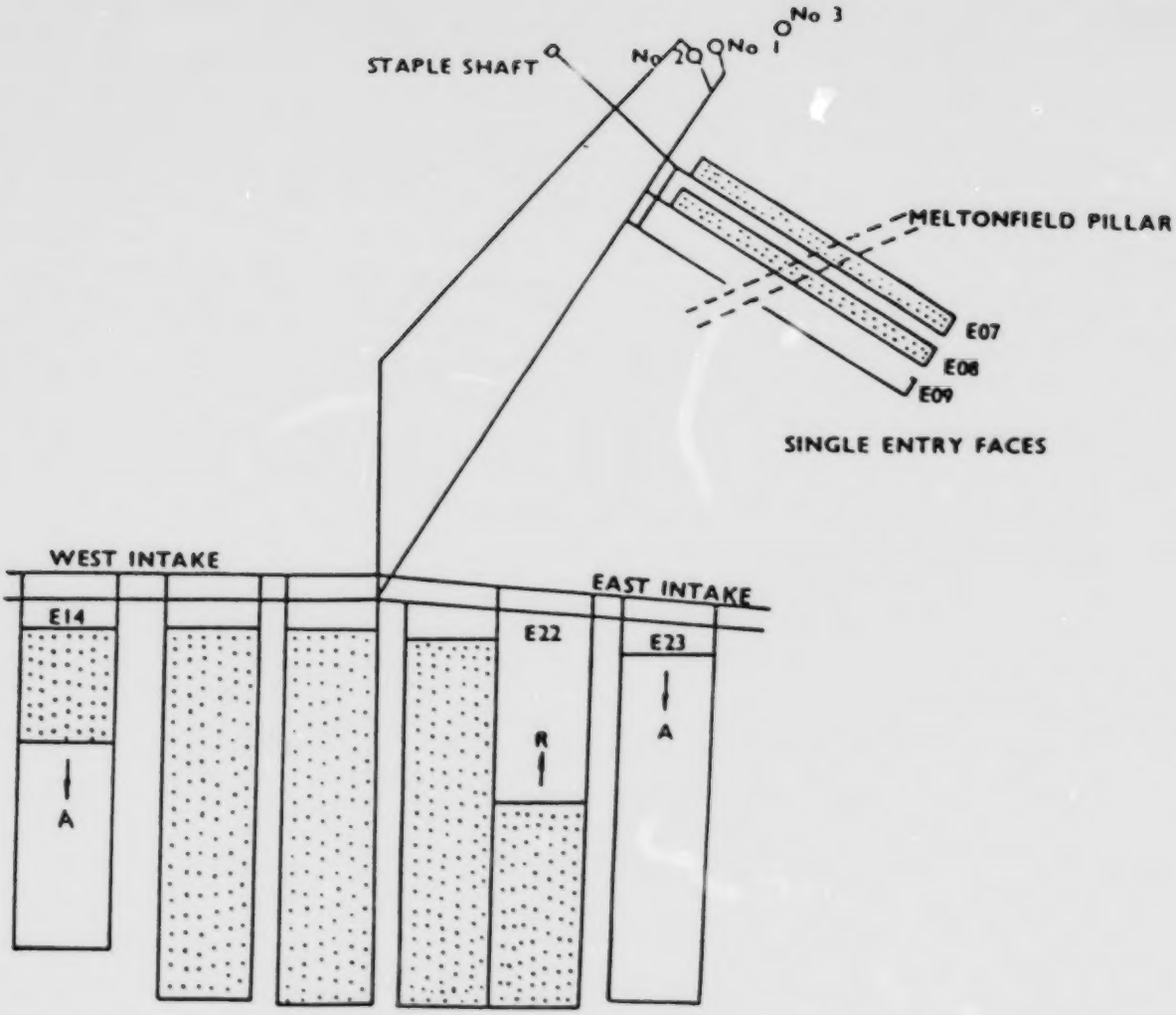


GRETLEY MINE - FACE END ARRANGEMENTS (Source: Ref.A13)



GRETLEY MINE - MAIN GATE LAYOUT (Source: Ref.A12)

FIGURE 4-35

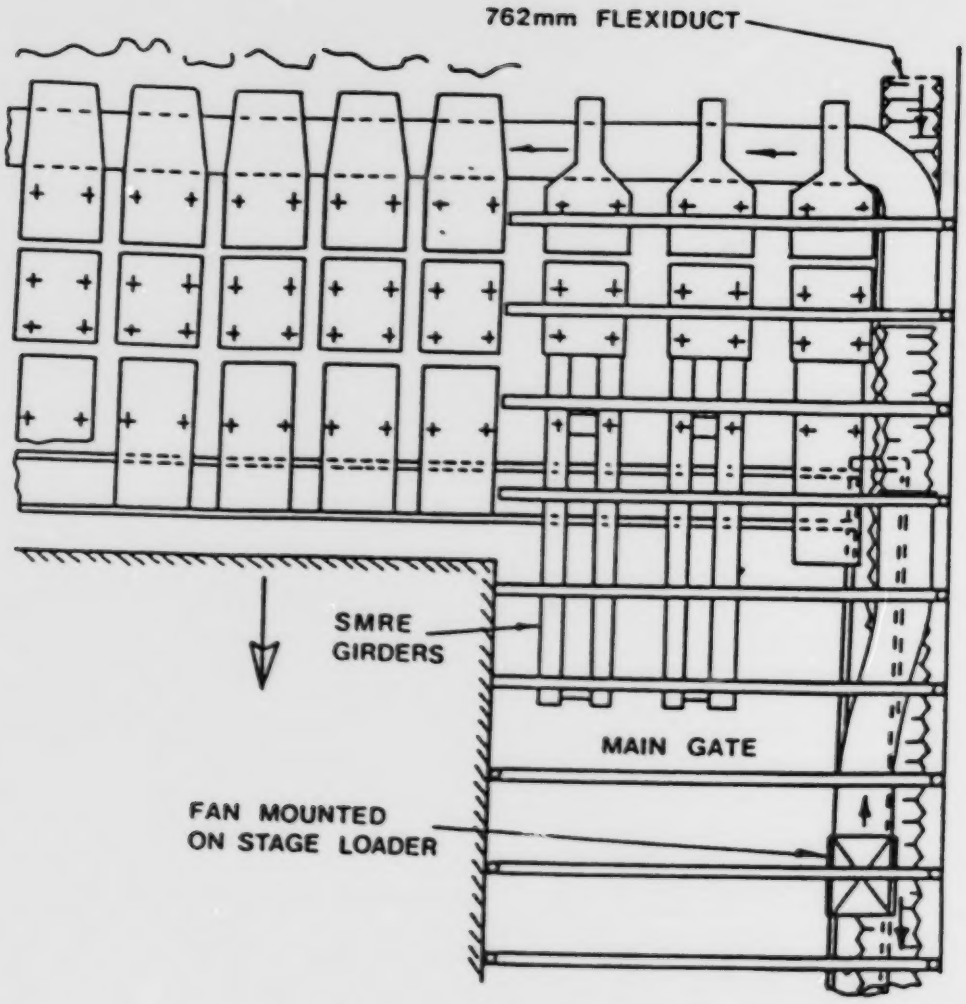


Layout of Faces in the Newhill Seam

SOUTH KIRKBY MINE - PLAN

FIGURE 4-36

(Source: Ref.A8)



SOUTH KIRKBY MINE - FACE END LAYOUT

(Source: Ref.A8)

FIGURE 4 - 37

FIGURE 4-38

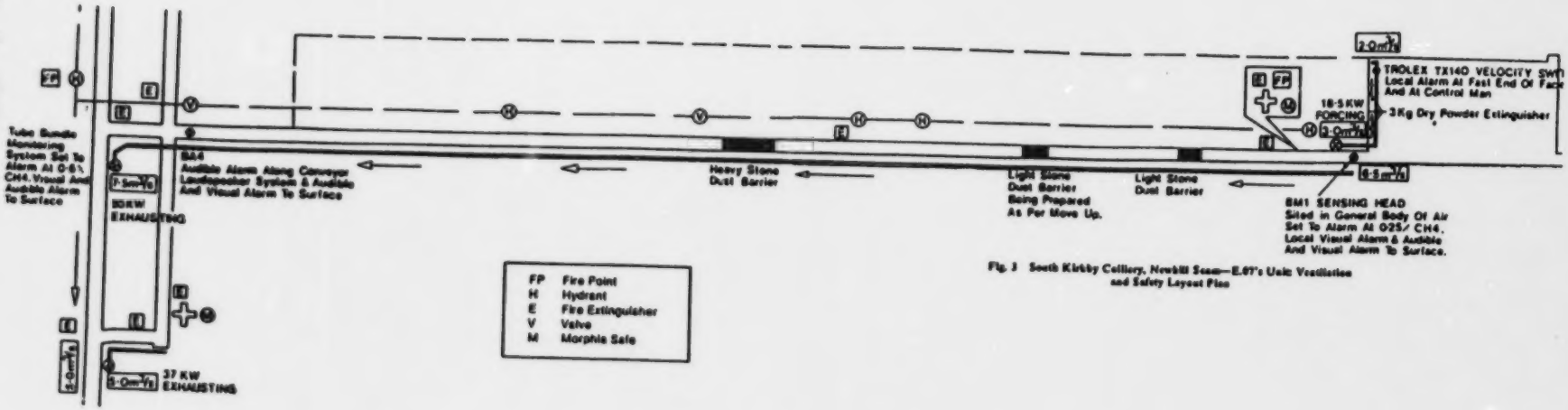
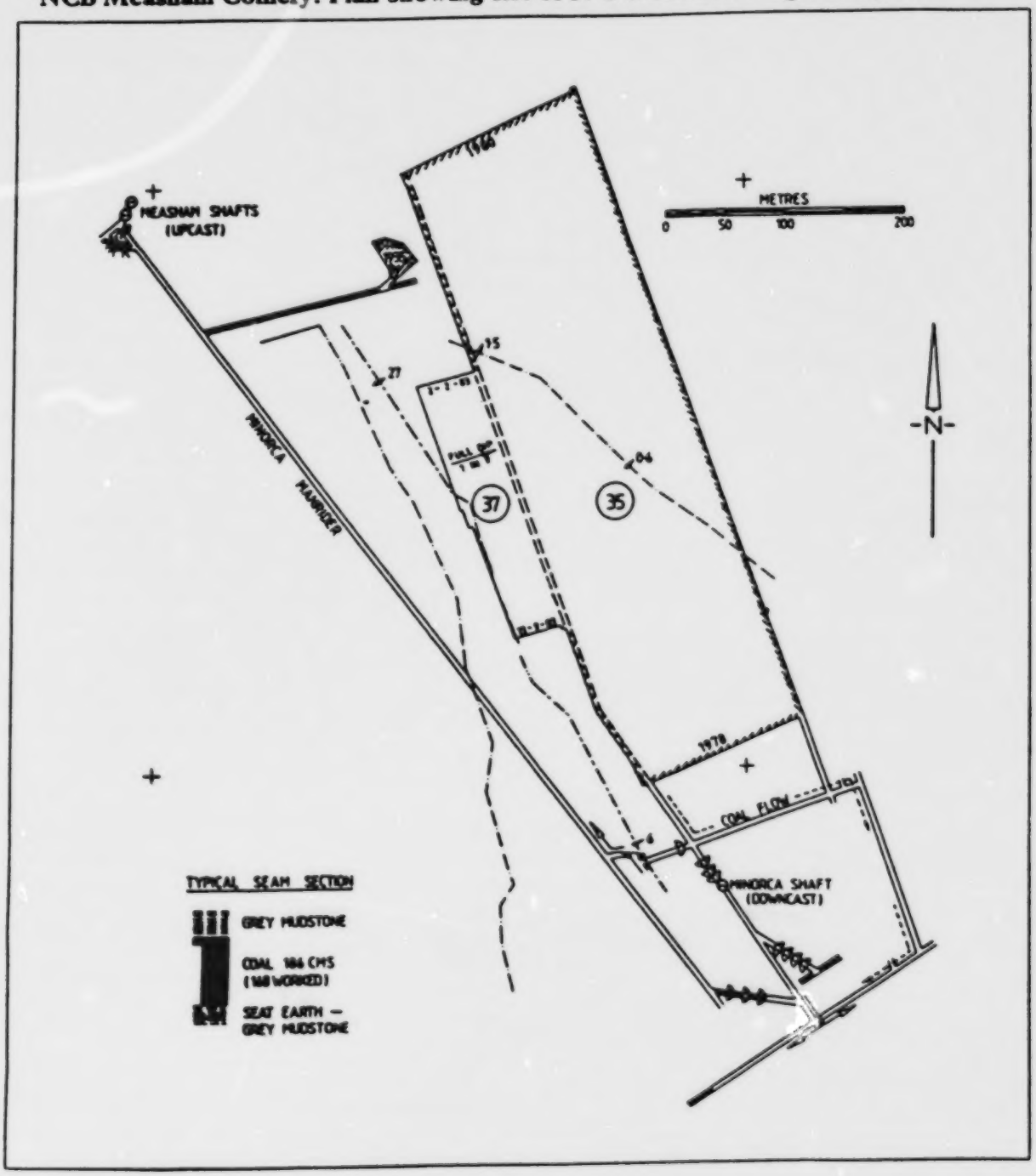


Fig. 3 South Kirkby Colliery, Newhill Seam—E.07's Unit Ventilation and Safety Layout Plan

SOUTH KIRKBY MINE - VENTILATION PLAN

(Source: Ref.A8)

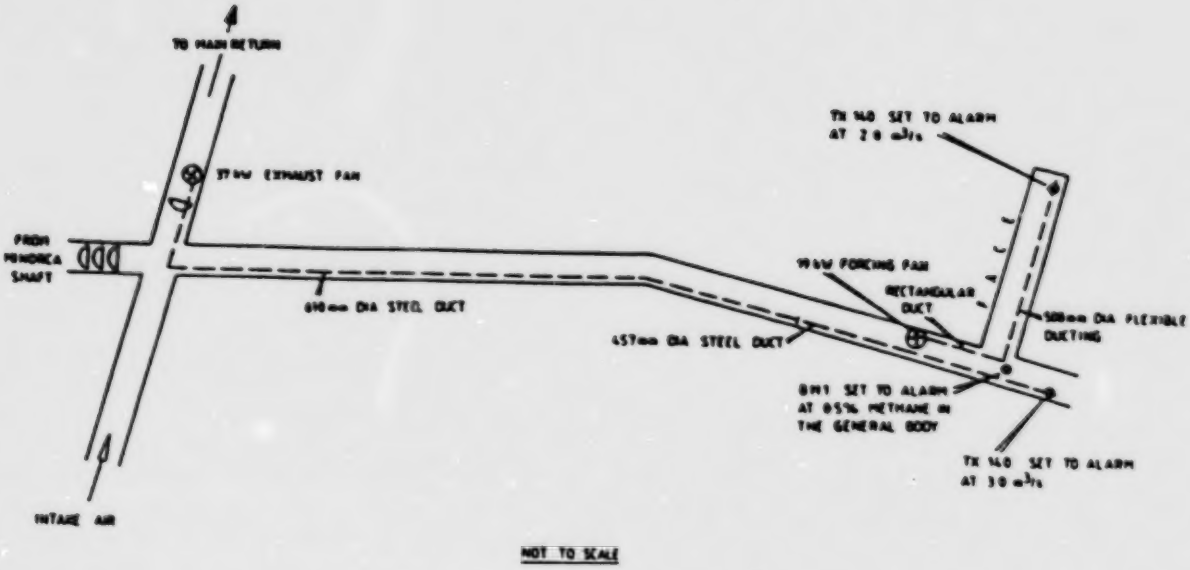
NCB Measham Colliery: Plan showing site of 37's Woodfield single entry face.



MEASHAM MINE - PLAN

(Source: Ref.A10)

FIGURE 4-39

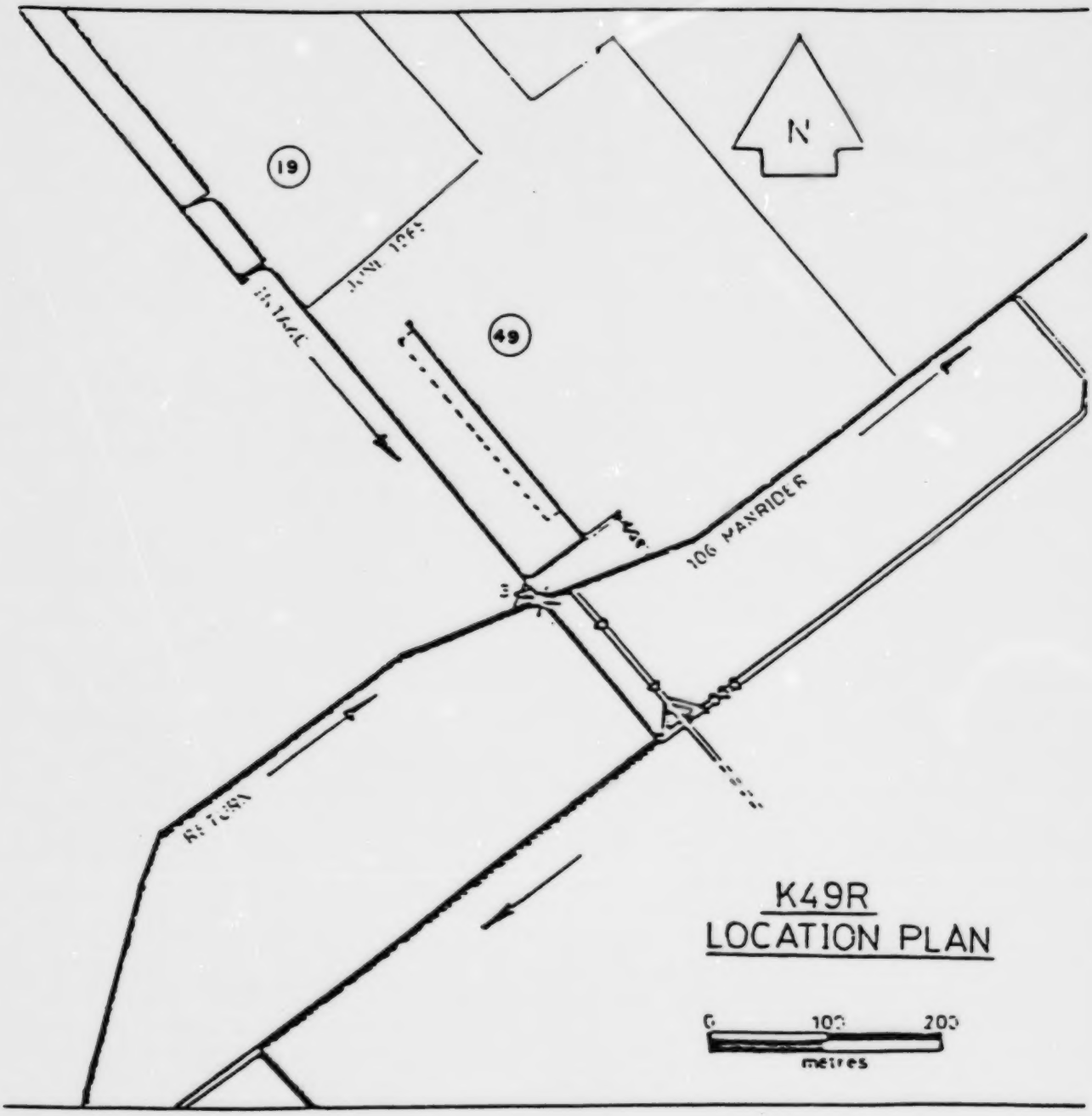


NCB Measham Colliery: 37's Woodfield single entry face ventilation arrangements.

MEASHAM MINE - VENTILATION PLAN

FIGURE 4-40

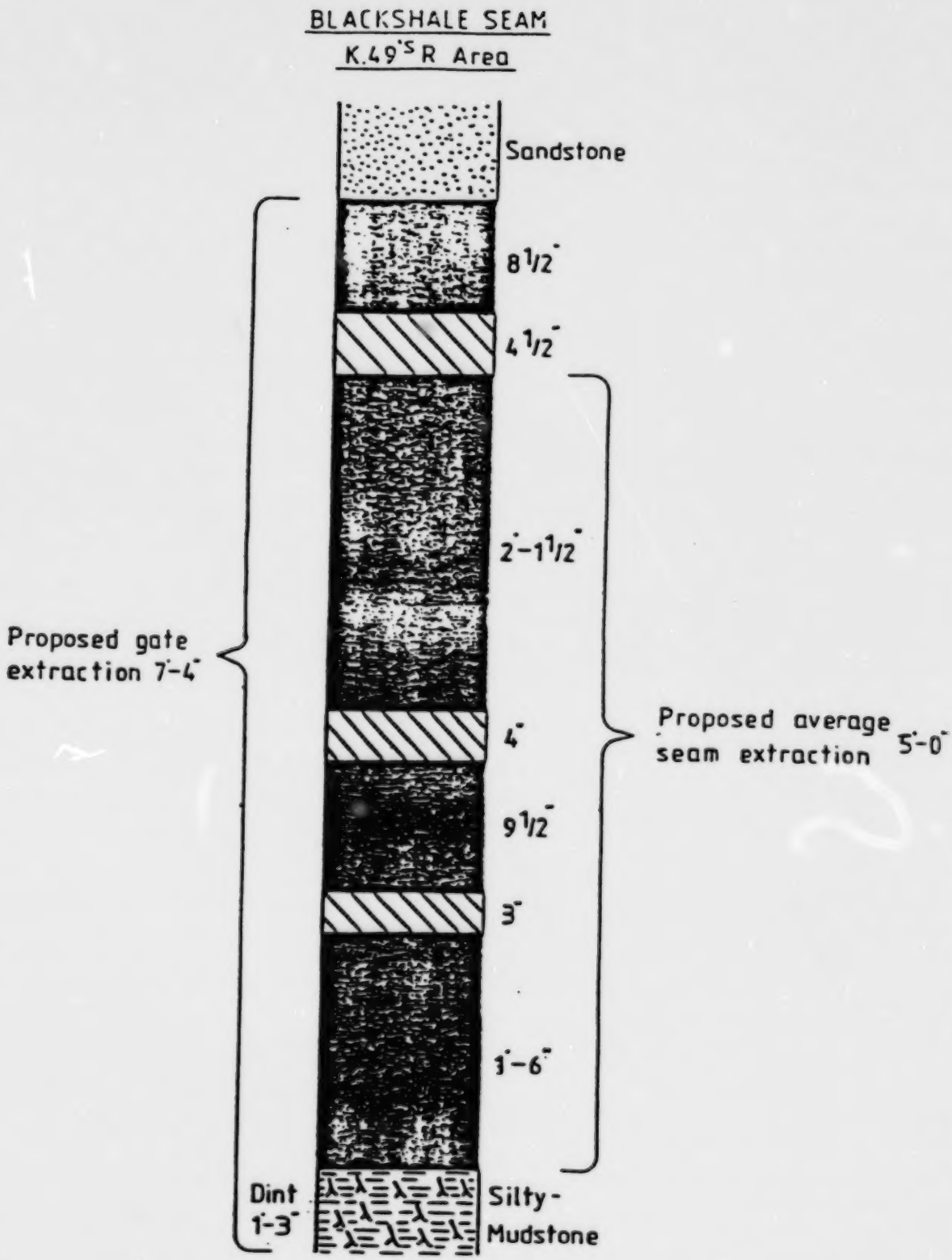
(Source: Ref.A10)



PYE HILL MINE - PLAN

(Source: Ref.A7)

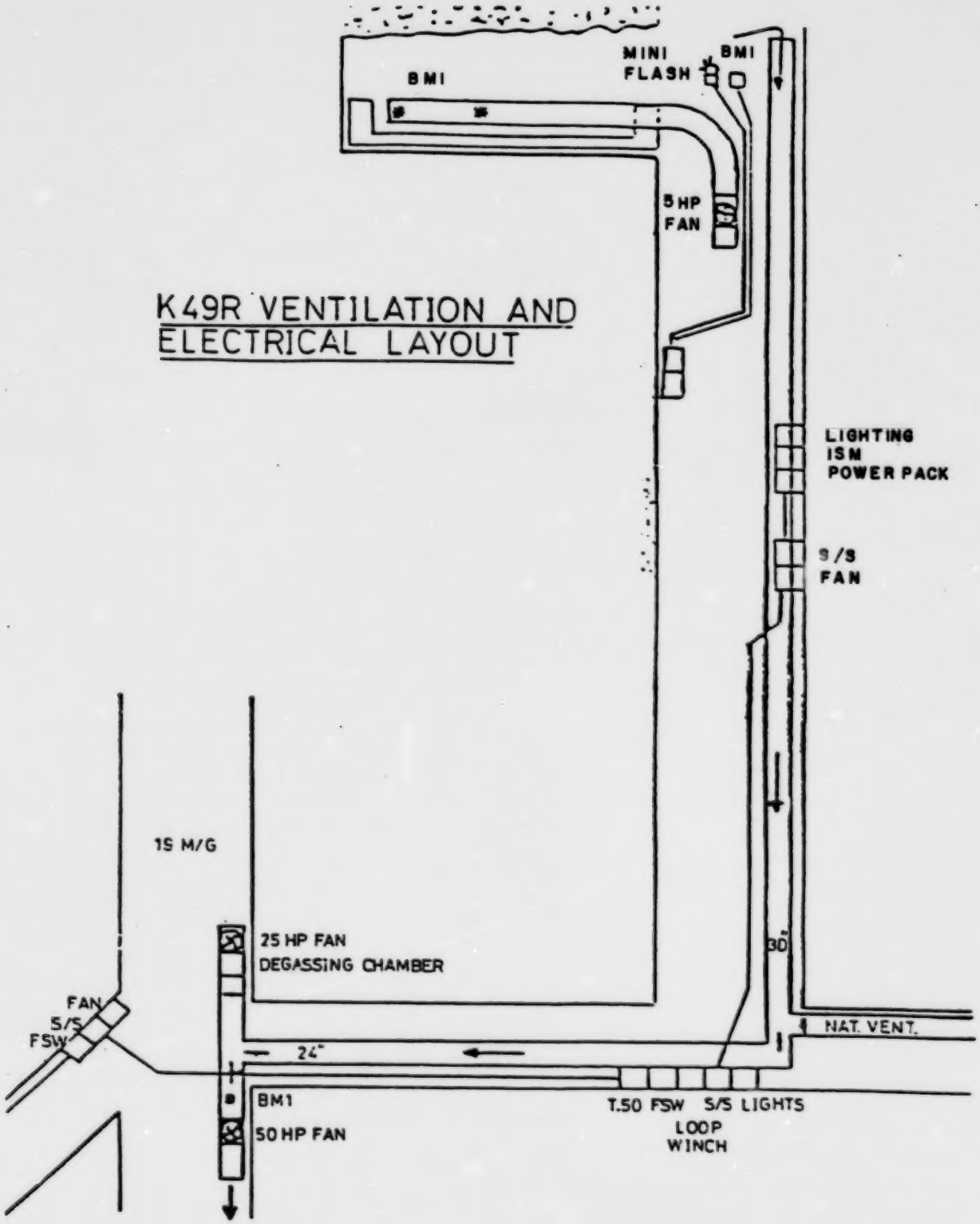
FIGURE 4-41



PYE HILL MINE - BLACKSHALE SEAM

FIGURE 4-42

(Source: Ref.A7)

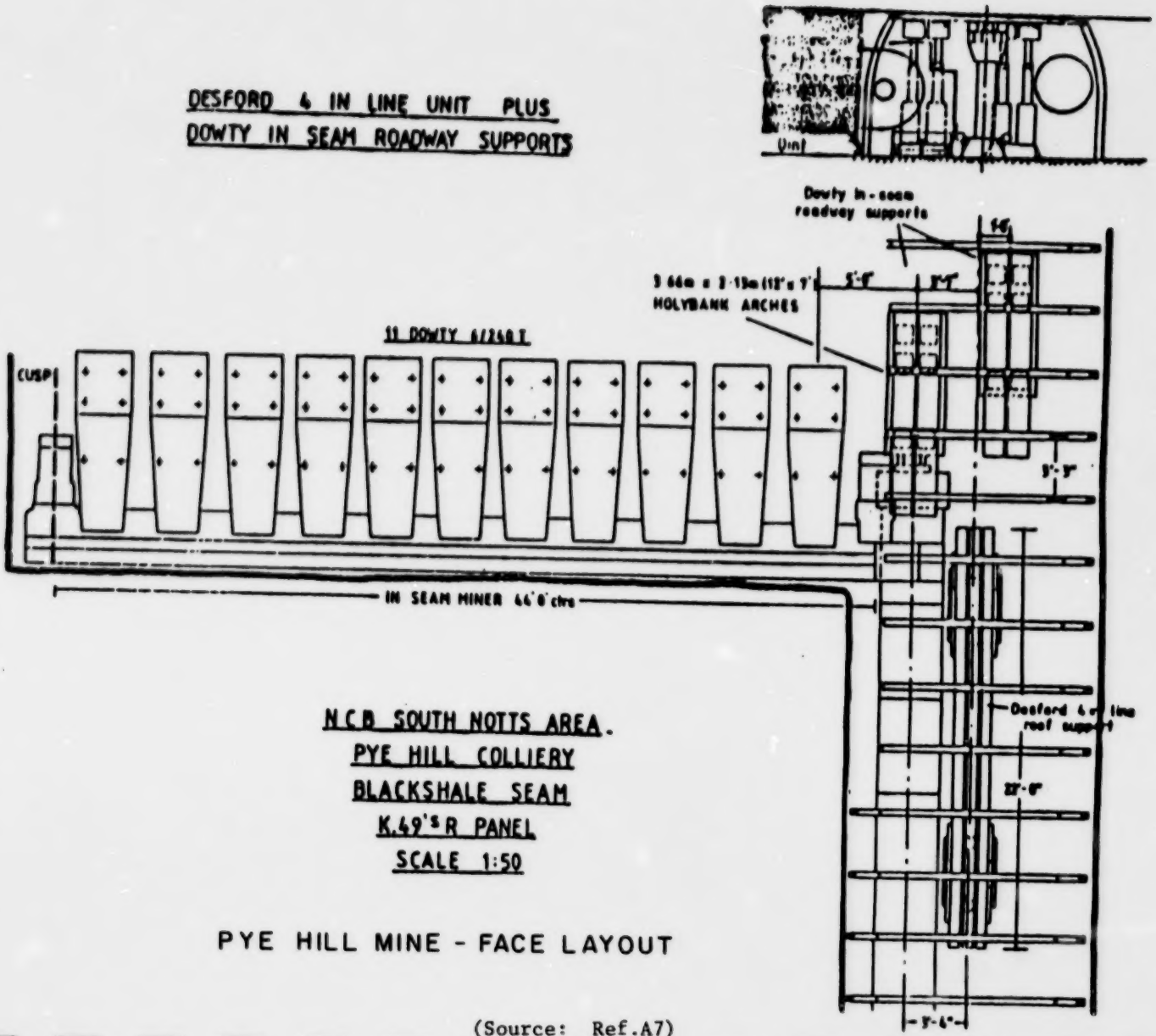


PYE HILL MINE - VENTILATION PLAN

(Source: Ref.A7)

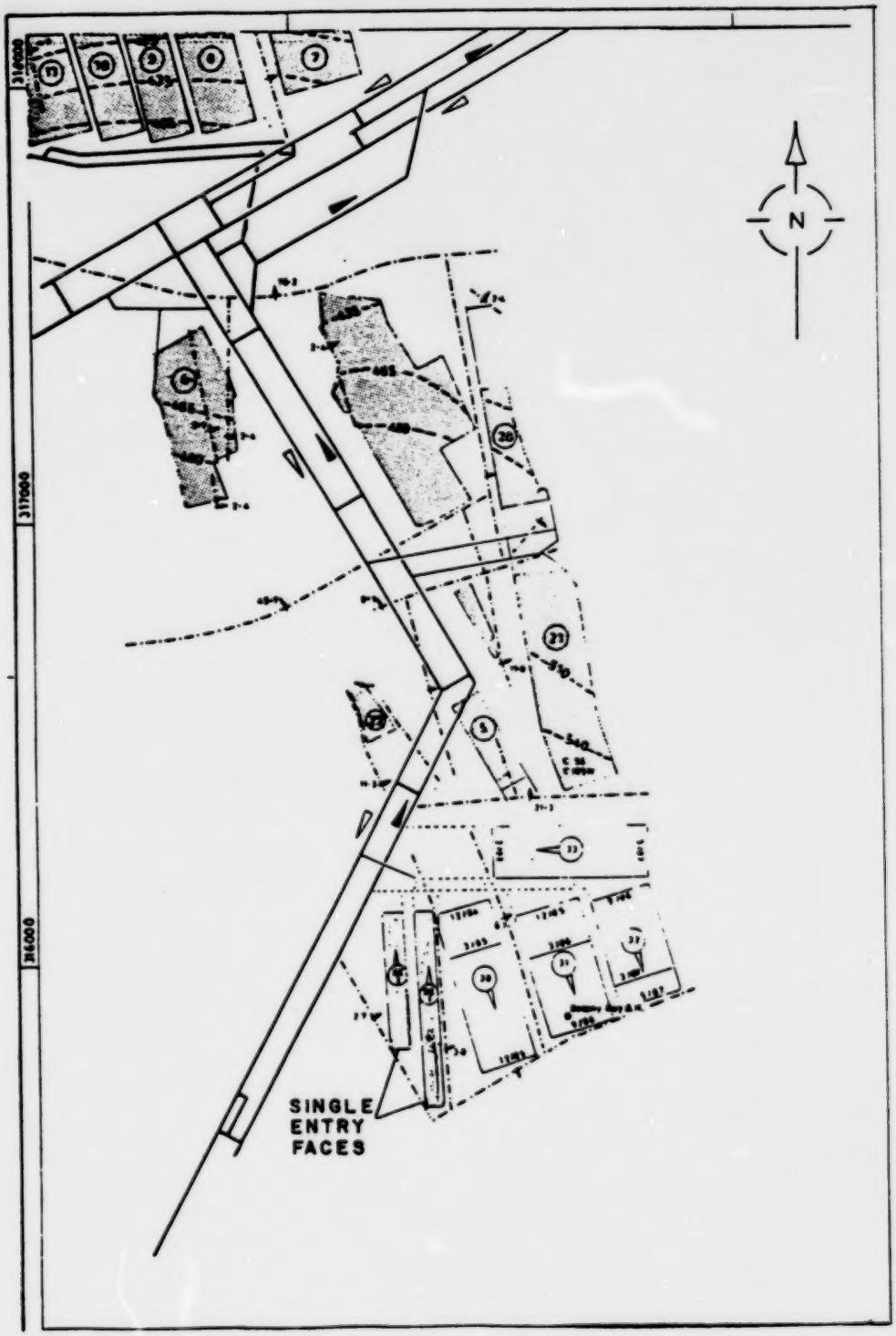
FIGURE 4-43

FIGURE 4-44



PYE HILL MINE - FACE LAYOUT

(Source: Ref.A7)



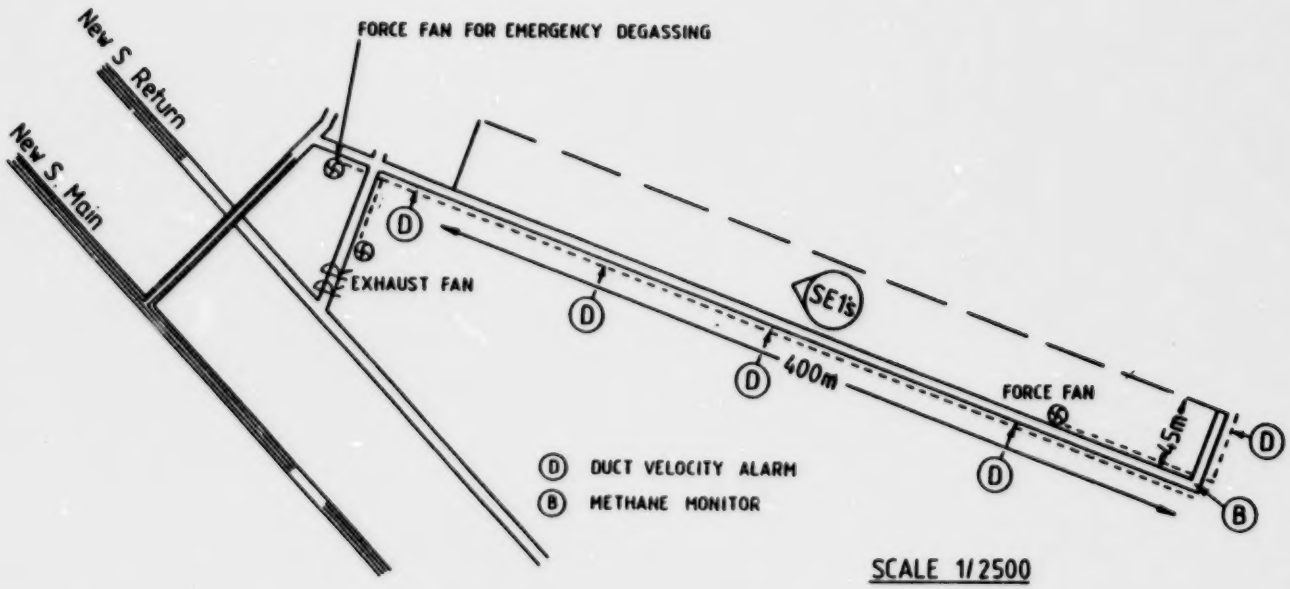
CADLEY HILL MINE - PLAN

(Source: Ref.A11)

FIGURE 4 - 45

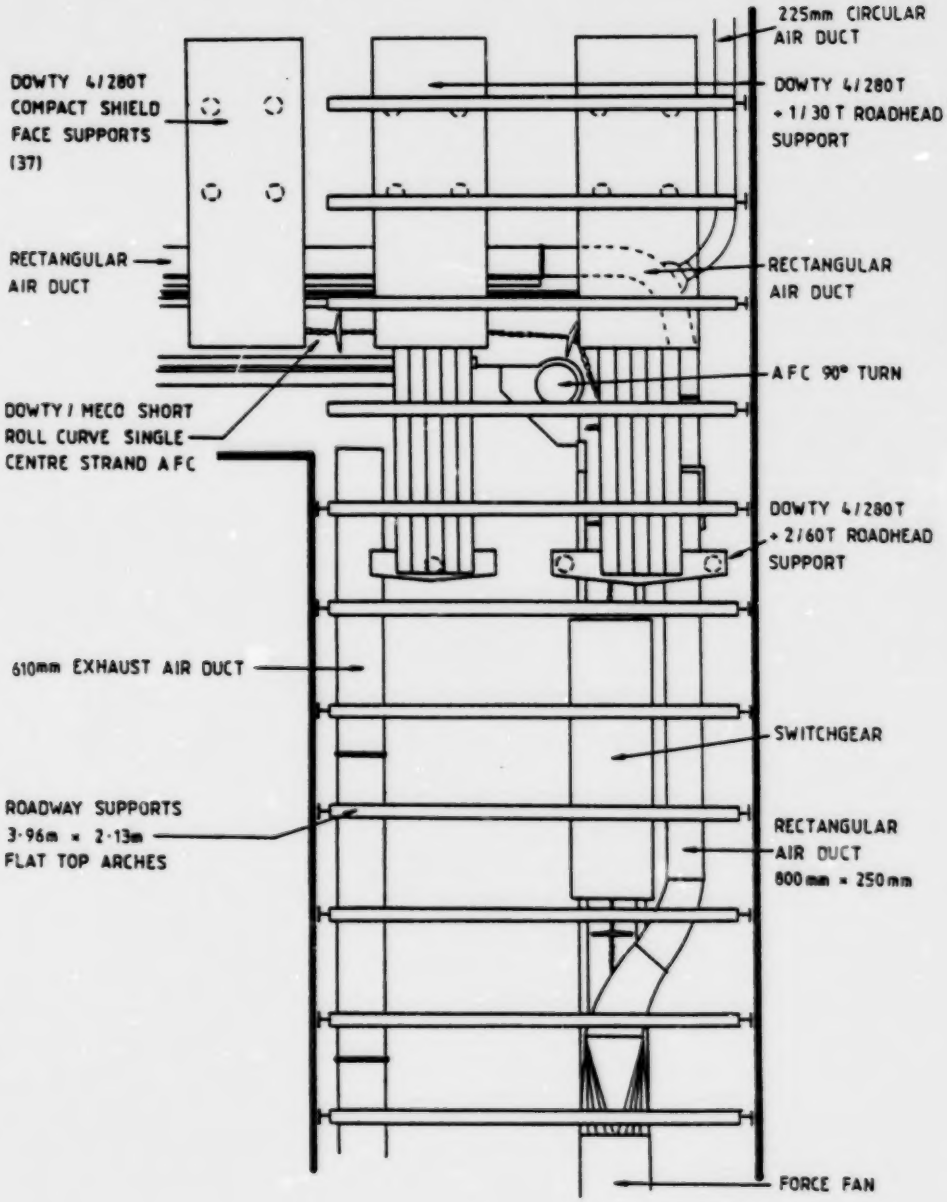
FIGURE 4-46

CADLEY HILL COLLIERY
SE 1's SINGLE ENTRY RETREAT FACE
VENTILATION



CADLEY HILL MINE - VENTILATION PLAN (Source: Ref.A11)

ROADHEAD



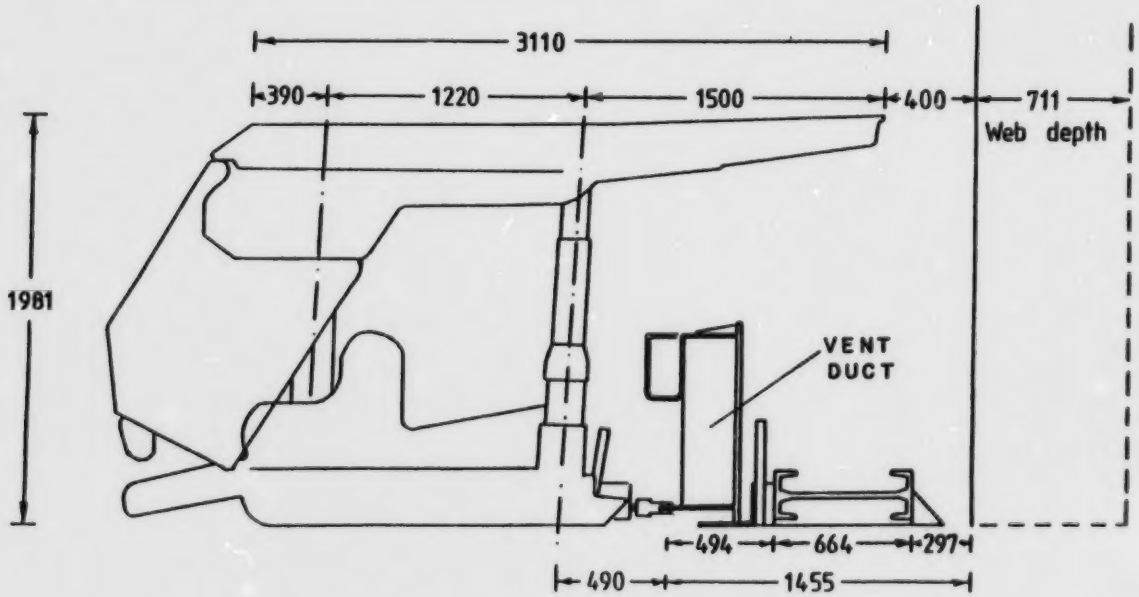
CADLEY HILL MINE - ROADHEAD SUPPORT

(Source: Ref.A11)

FIGURE 4-47

SE 1s PANEL
FACE ZONE

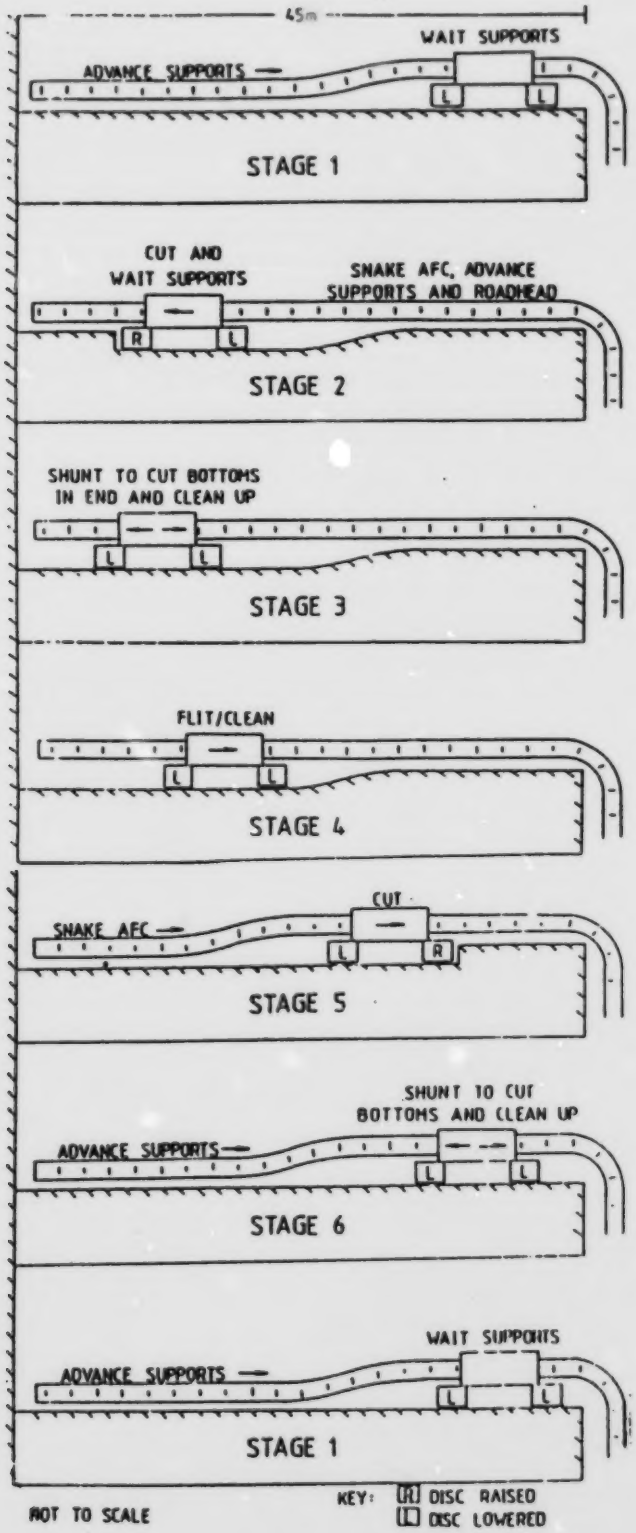
DOWTY 4/280 Compact Chock Shield Support
(1500mm Front Cantilever Beam)



CADLEY HILL MINE - FACE SECTION (Source: Ref.A11)

FIGURE 4-48

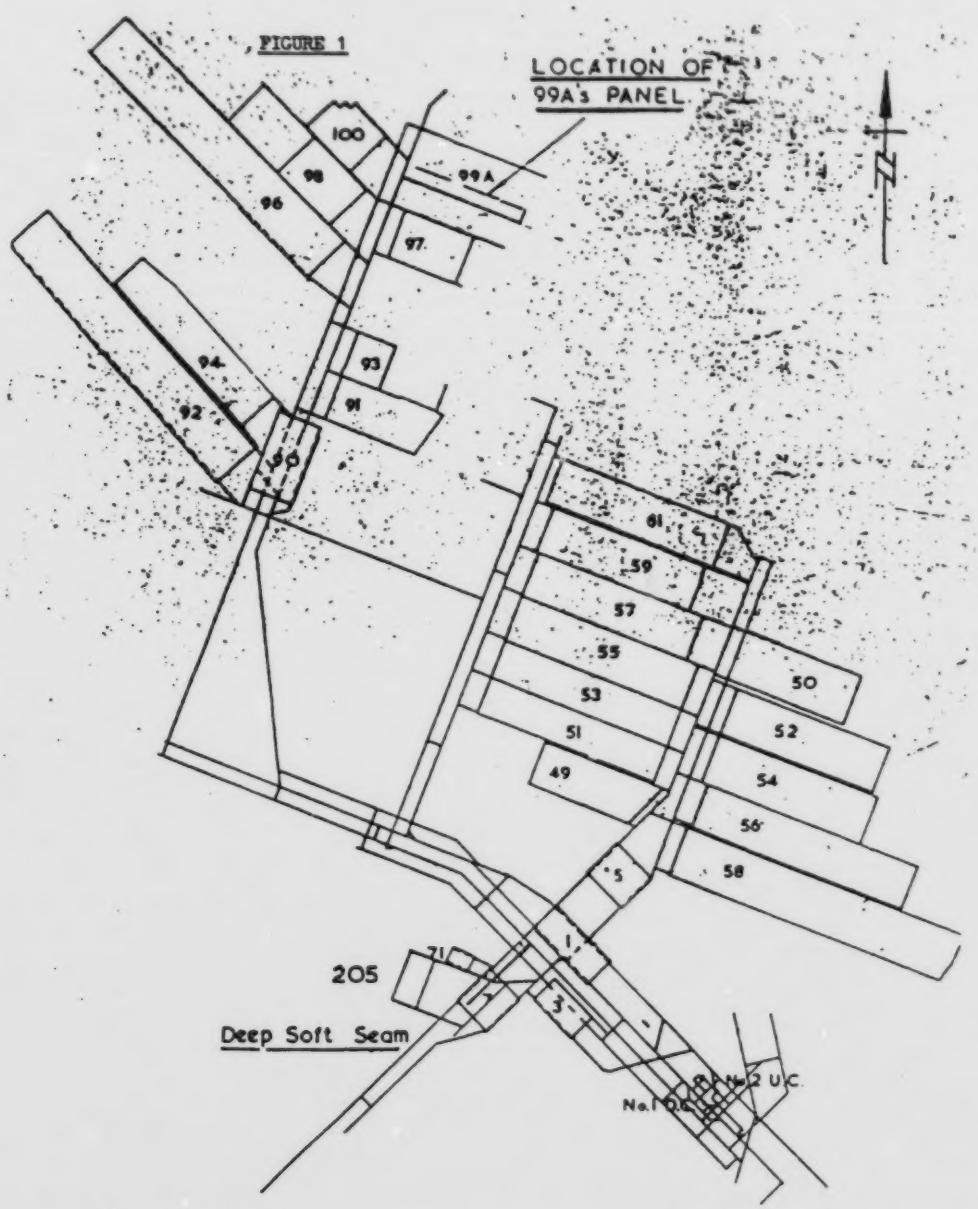
NORMAL CYCLE



CADLEY HILL MINE - CUTTING SEQUENCE

(Source: Ref.A11)

FIGURE 4-49



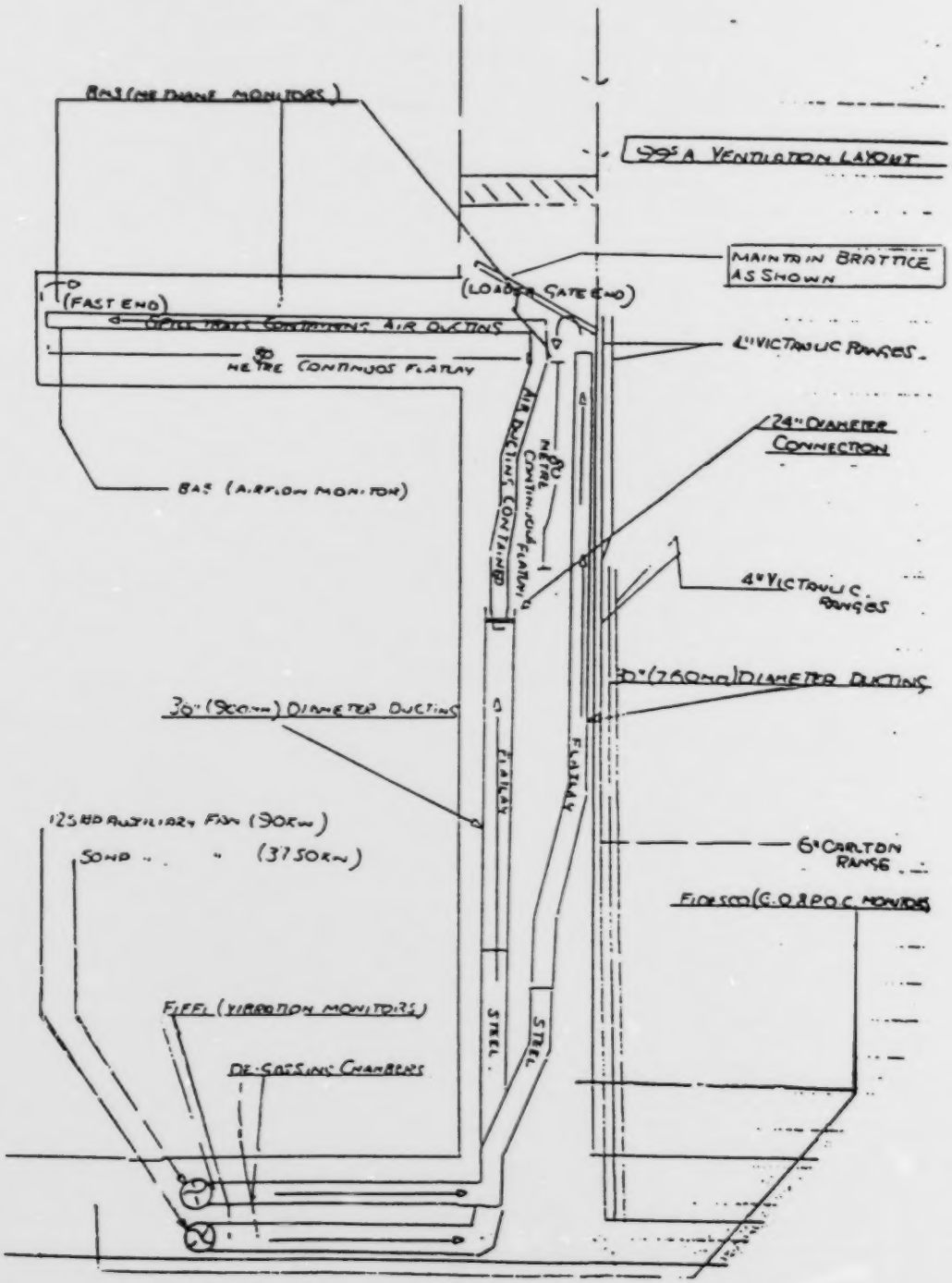
— LOCATION PLAN OF THE PARKGATE SEAM —

SCALE 1 : 25000

BEVERCOTES MINE - PLAN

FIGURE 4-50

(Source: Ref.A6)

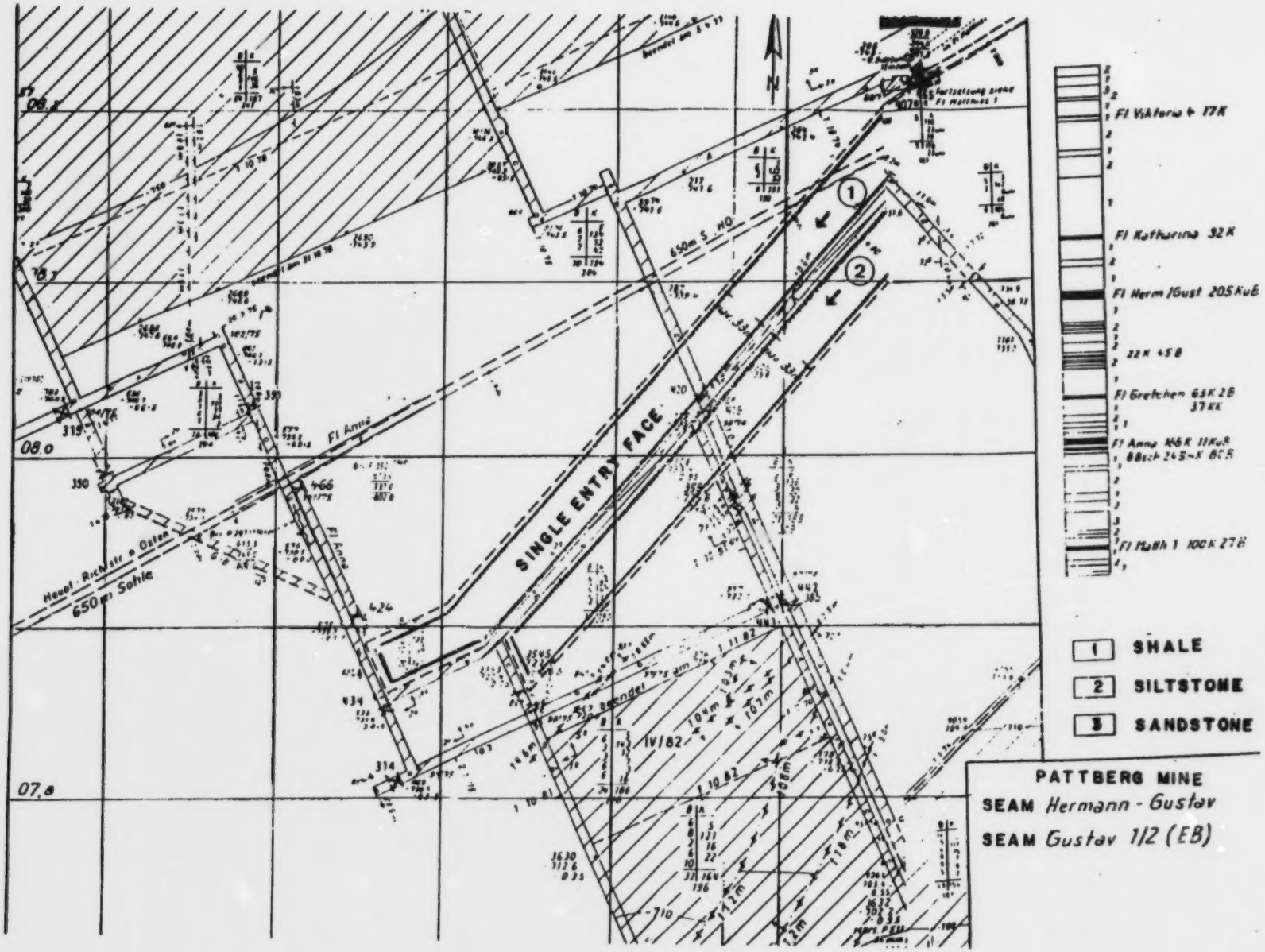


BEVERCOTES MINE - VENTILATION PLAN

(Source: Ref.A6)

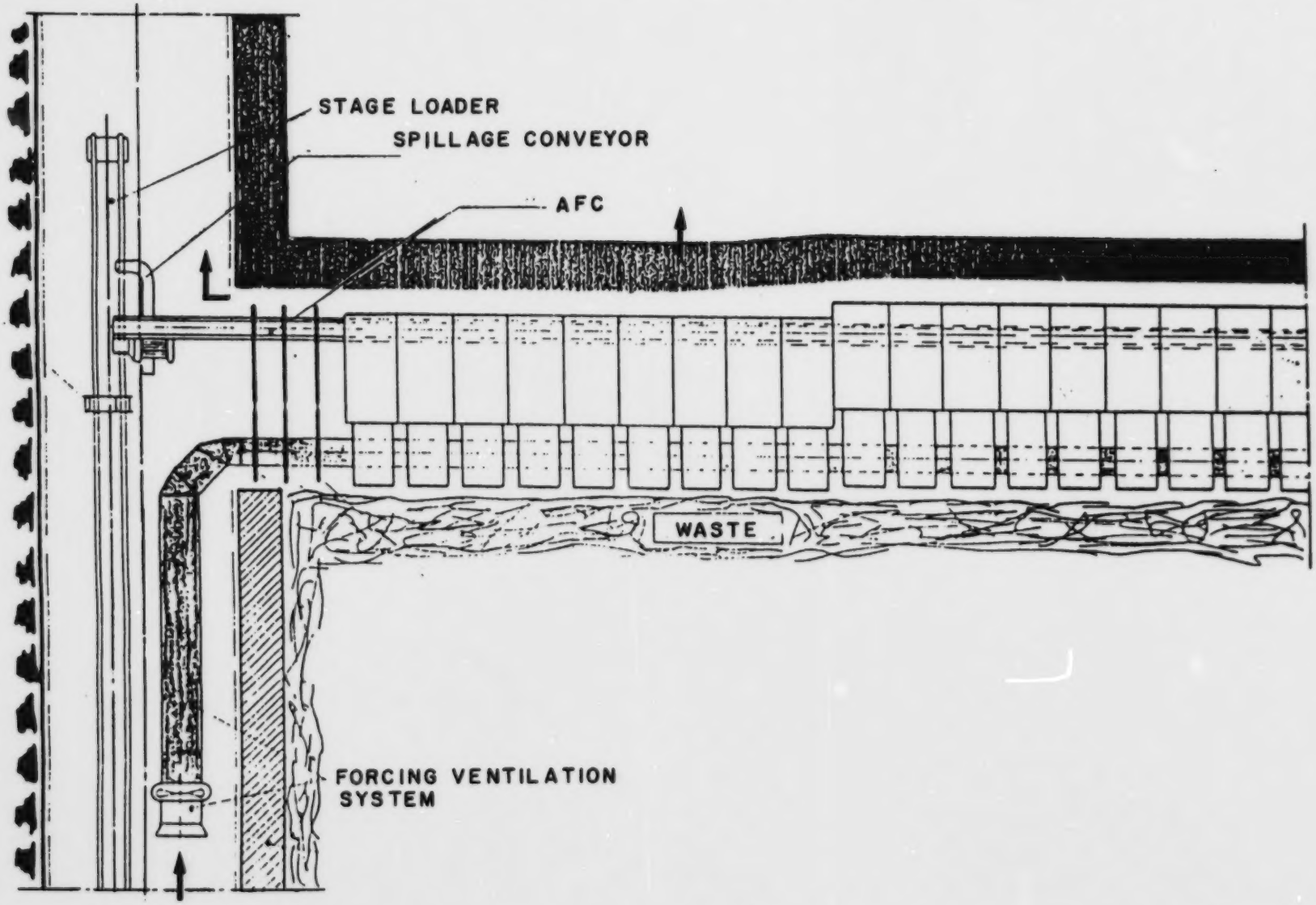
FIGURE 4-51

FIGURE 4-52



RHEINLAND MINE - PLAN

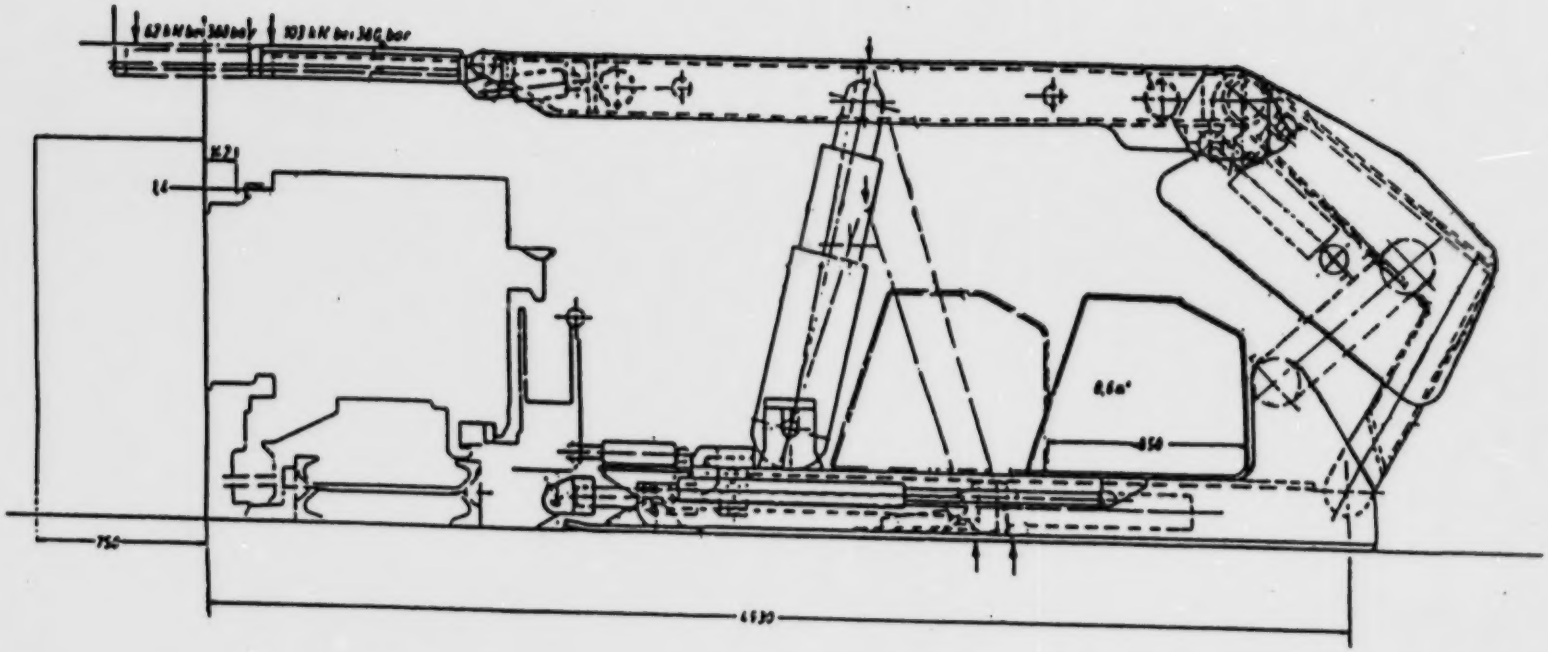
(Source: Ref.A16)



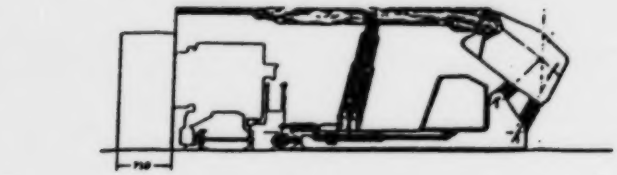
RHEINLAND MINE - FACE LAYOUT (Source: Ref.A16)

FIGURE 4-53

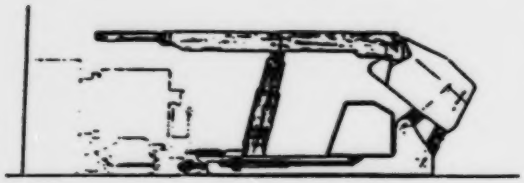
FIGURE 4-54



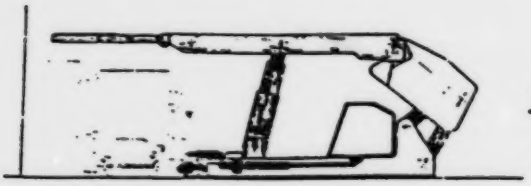
RHEINLAND MINE - FACE SECTION (Source: Ref.A16)



1 CYCLE STARTS

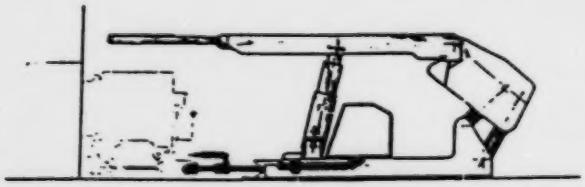


2 CUTTING COAL

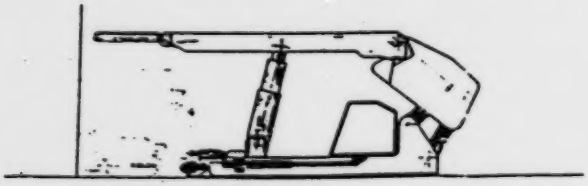


3 EXTENDING FORWARD CANTILEVER

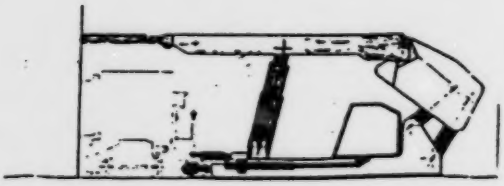
4 ADVANCING AFC AND COAL CUTTING MACHINE



5 ADVANCING VENTILATION DUCT



6 ADVANCING SUPPORTS

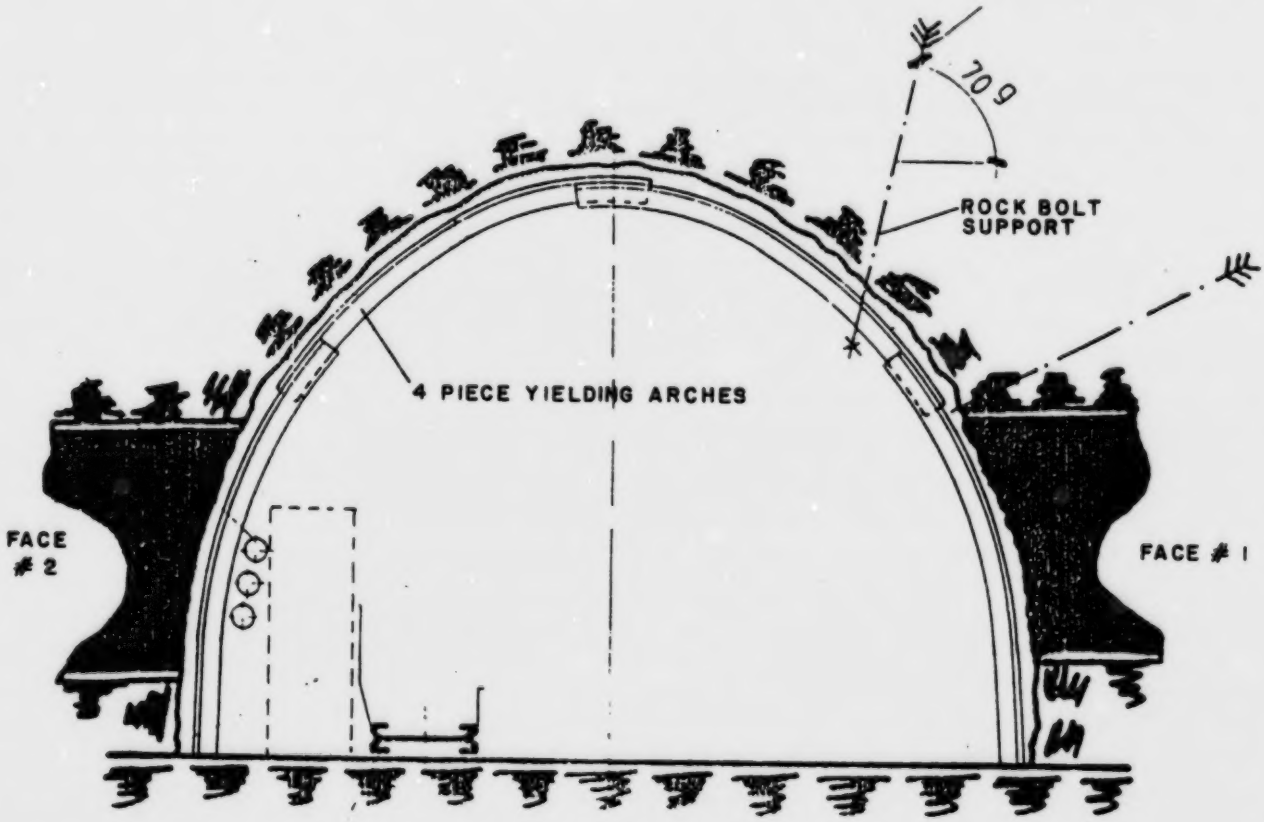


7 CYCLE COMPLETED

RHEINLAND MINE - EMERGENCY ADVANCE SEQUENCES

(Source: Ref.A16)

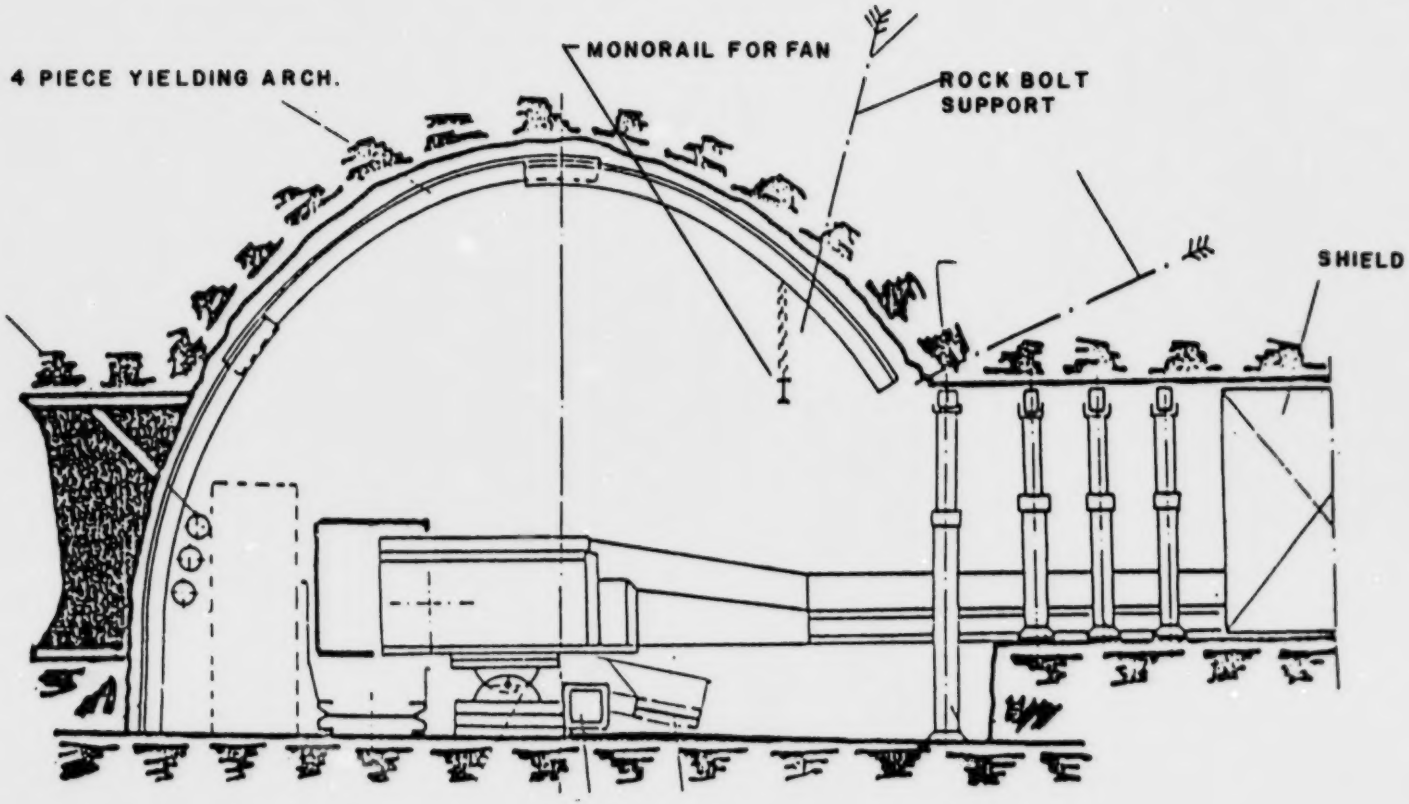
FIGURE 4 - 55



RHEINLAND MINE - ROADWAY SECTION

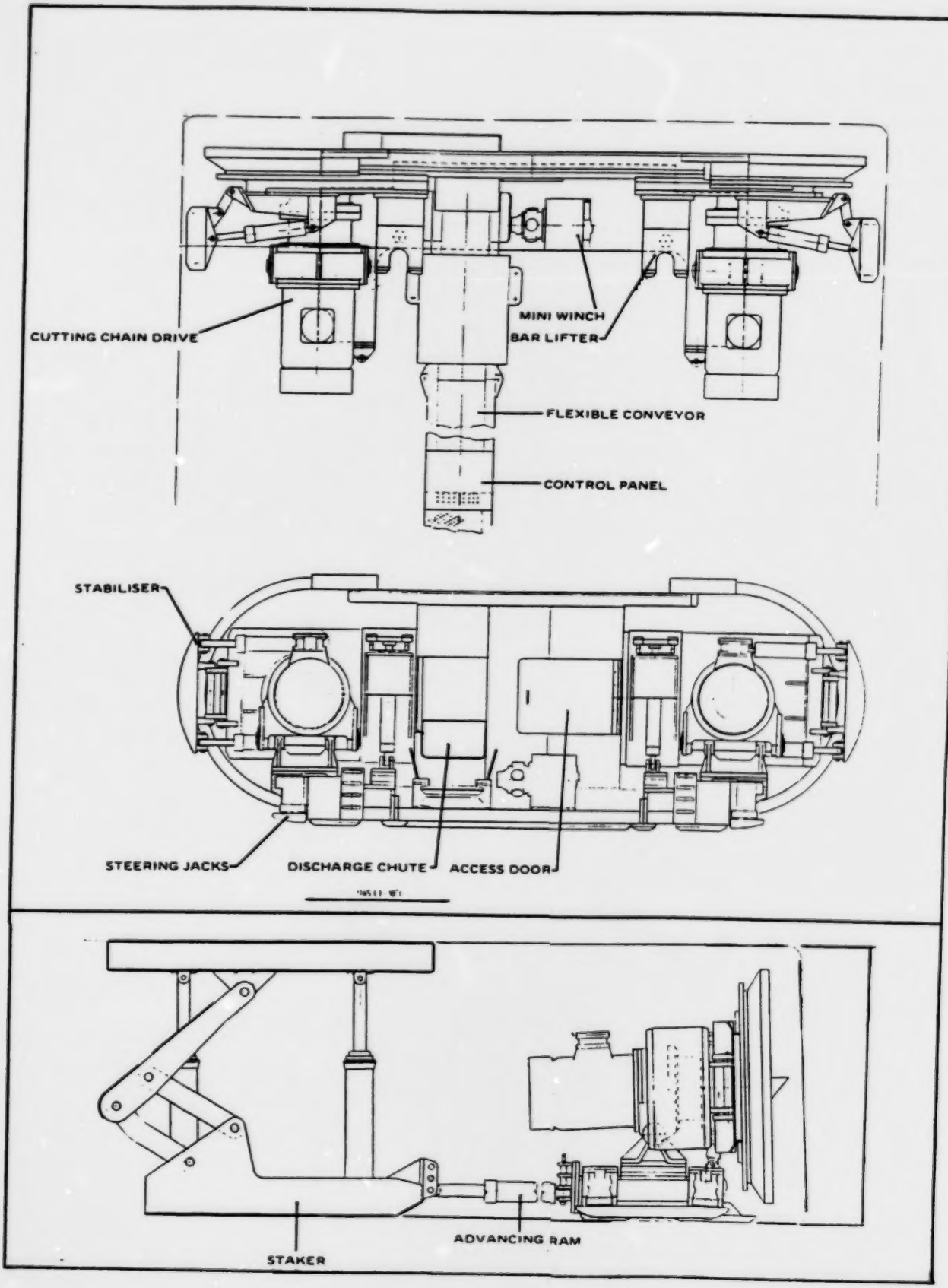
FIGURE 4-56

(Source: Ref.A16)



RHEINLAND MINE - ROADHEAD SECTION (Source: Ref. A16)

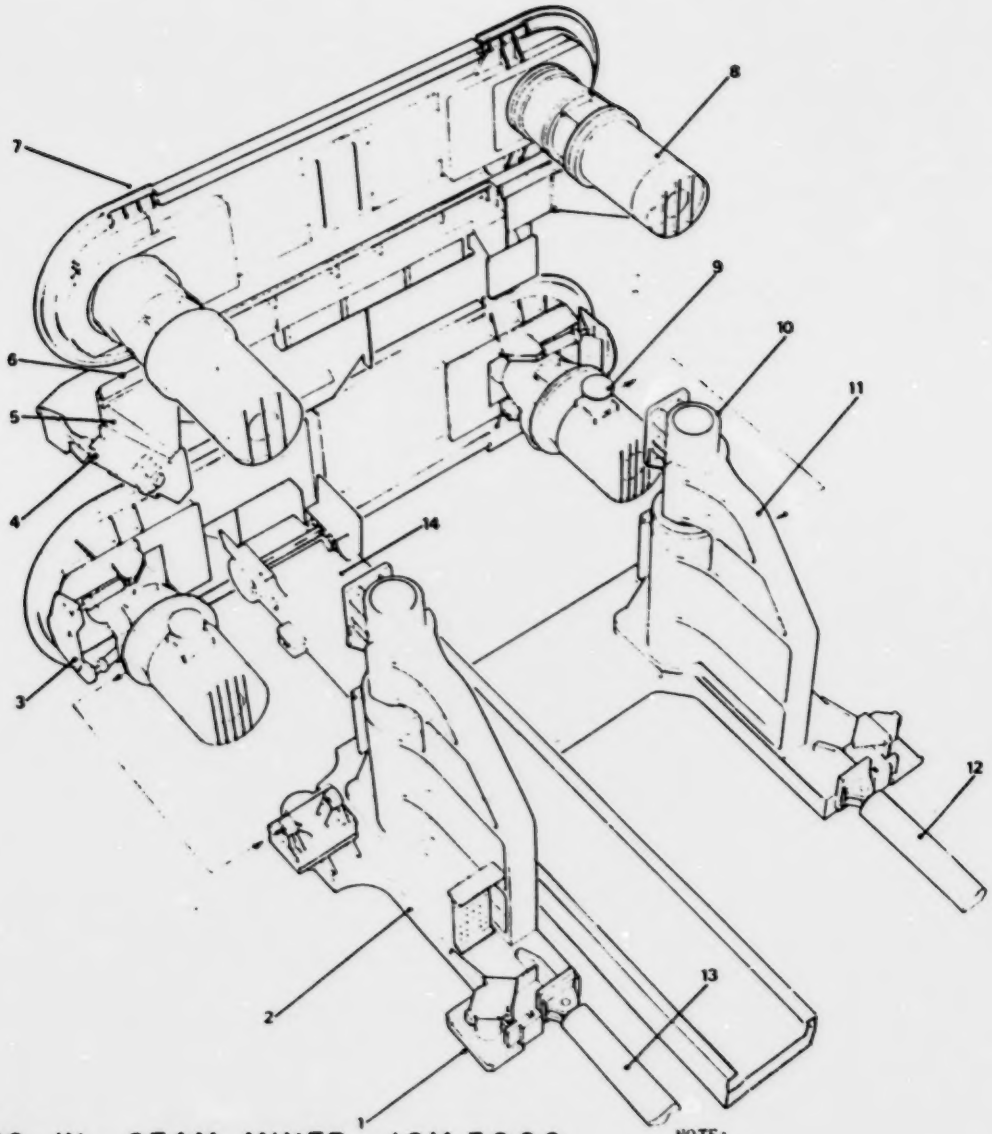
FIGURE 4-57



DOSCO IN-SEAM MINER-ISM 2000

FIGURE 4-58

(Source: Dosco)



Item	Component
1	Steering jacks.
2	Mainframe base.
3	Bottom jib LESS drive motors.
4	Hydraulic hammer with chisel and back plate.
5	Hammer bracket.
6	False floor LESS hammer brackets.
7	Top jib LESS drive motors.
8	Top jib motor.
9	Bottom jib motor.
10	Top frame tube.
11	Support column.
12	Advance/retract cylinder (200 mm bore).
13	Advance/retract cylinder (250 mm bore).
14	Conveyor return end.
15	Conveyor drive section and gearbox (LESS drive motor).
Not Shown	Conv. motor (similar to top jib).
Not Shown	Staker chock.

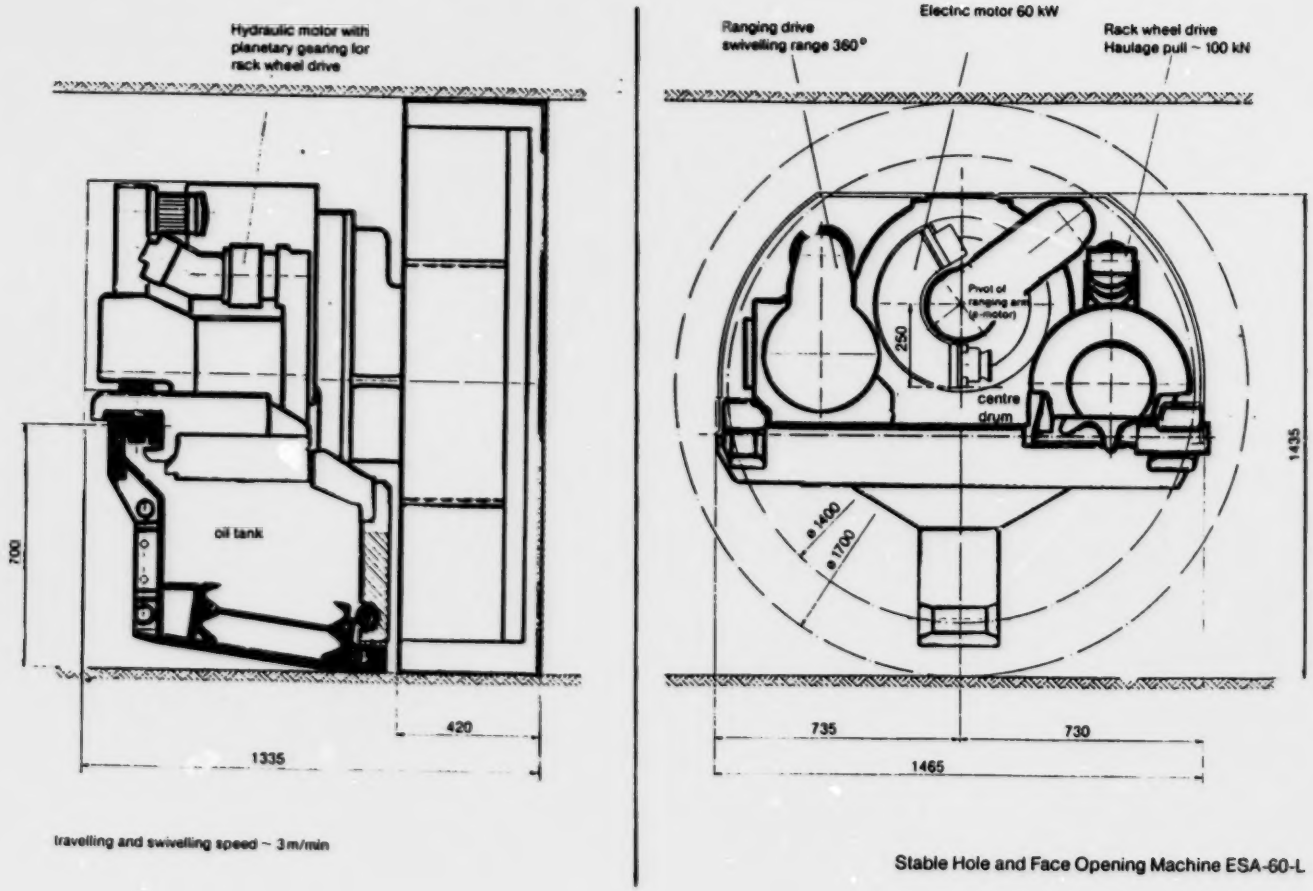
DOSCO IN - SEAM MINER - ISM 3000

NOTE:
The weight of the complete machine, LESS pushing cylinders, staker chocks and control panel is approximately 28 250 kg.

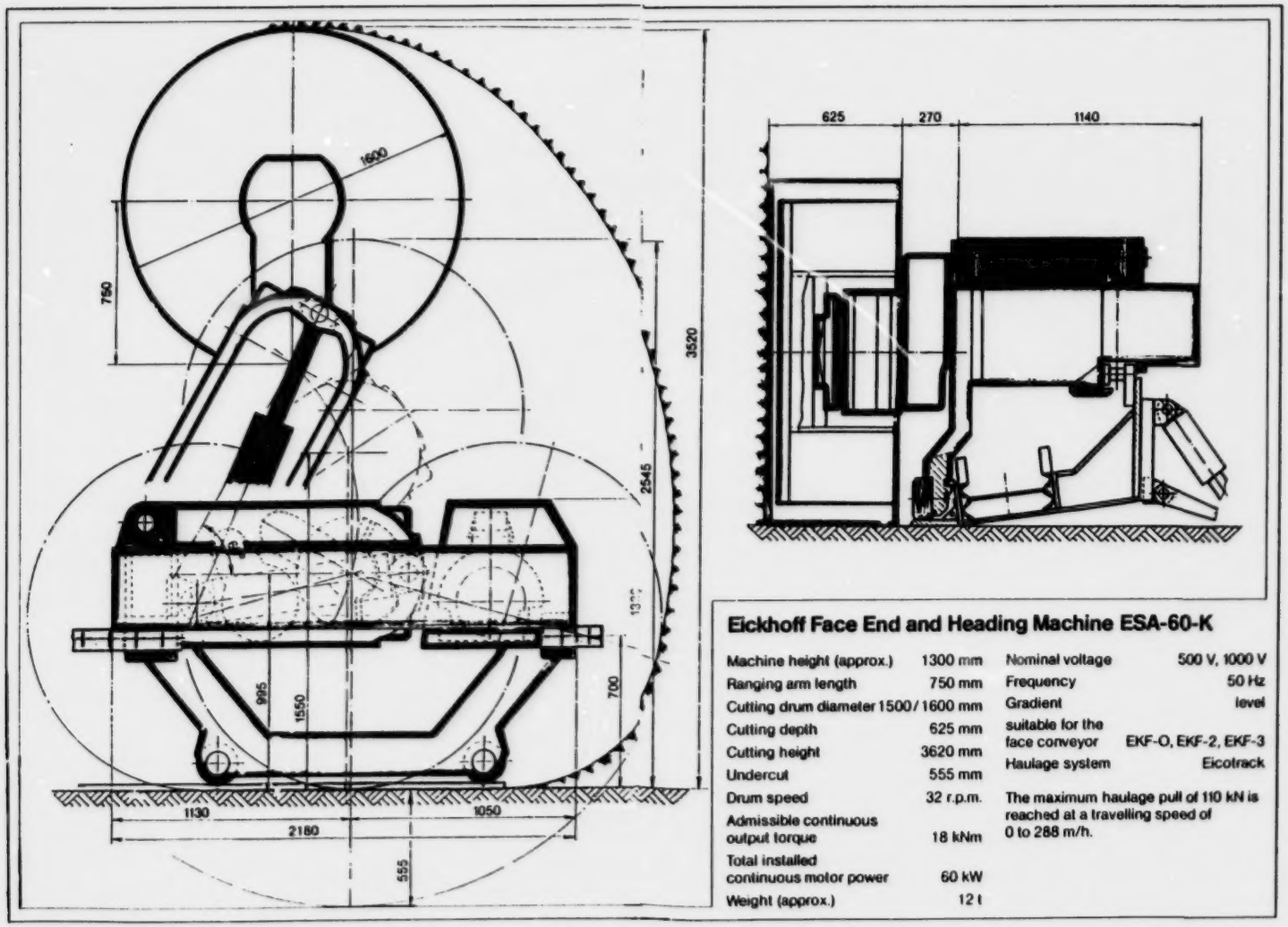
(Source: Dosco)

FIGURE 4 - 59

FIGURE 4-60

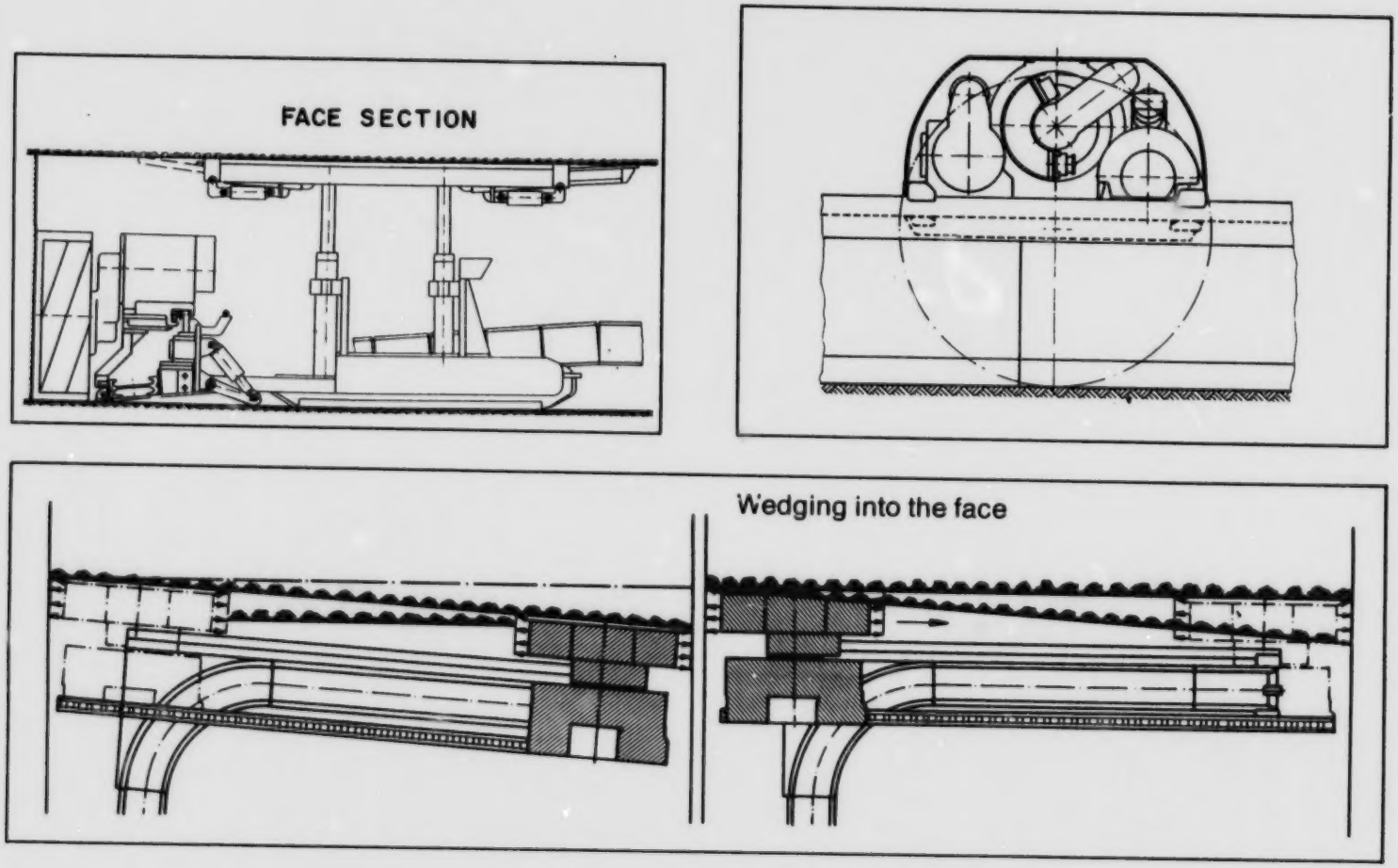


EICKHOFF ESA 60-L MACHINE (Source: Eickhoff)



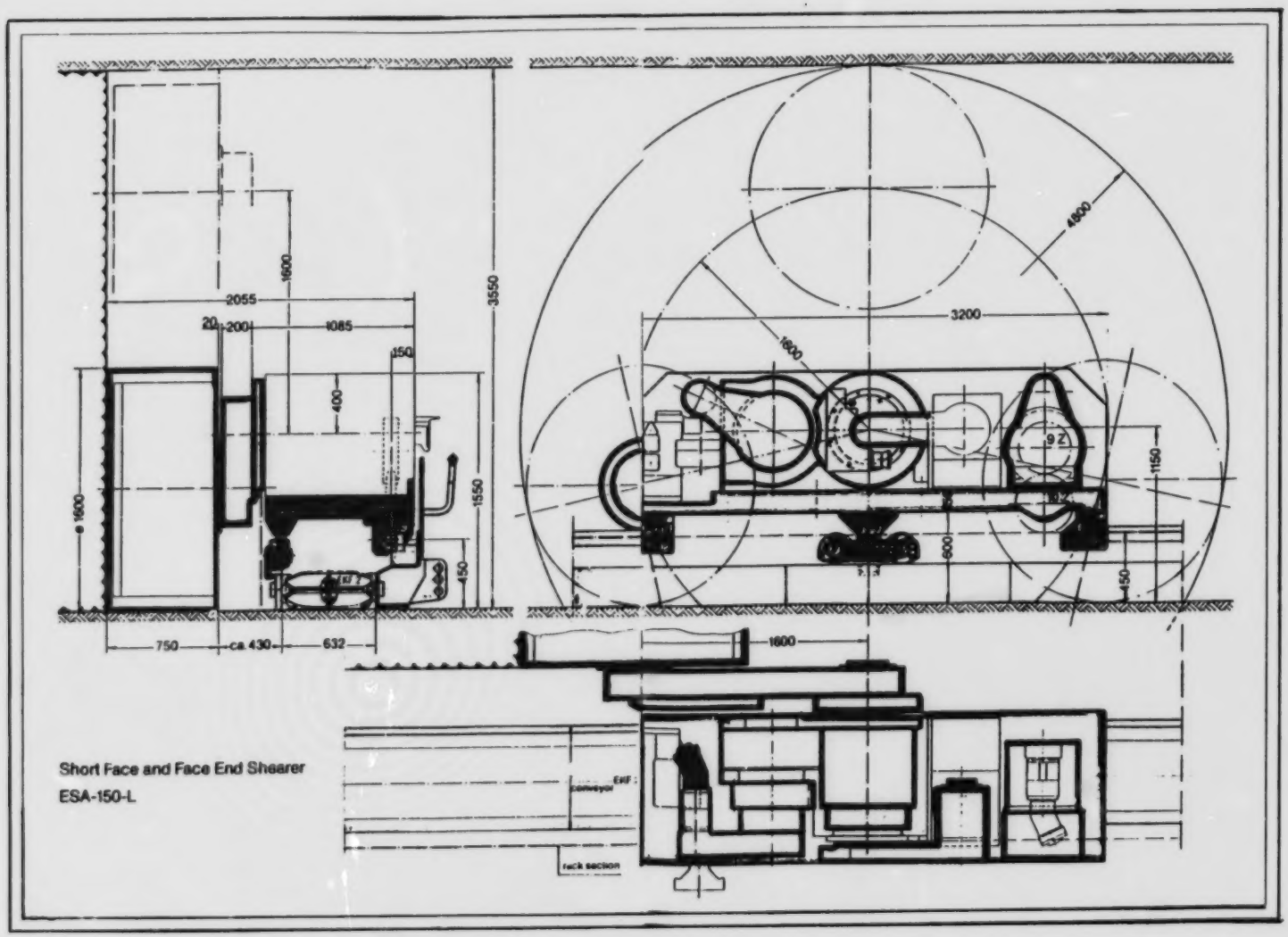
EICKHOFF ESA 60-K MACHINE (Source: Eickhoff)

FIGURE 4-61



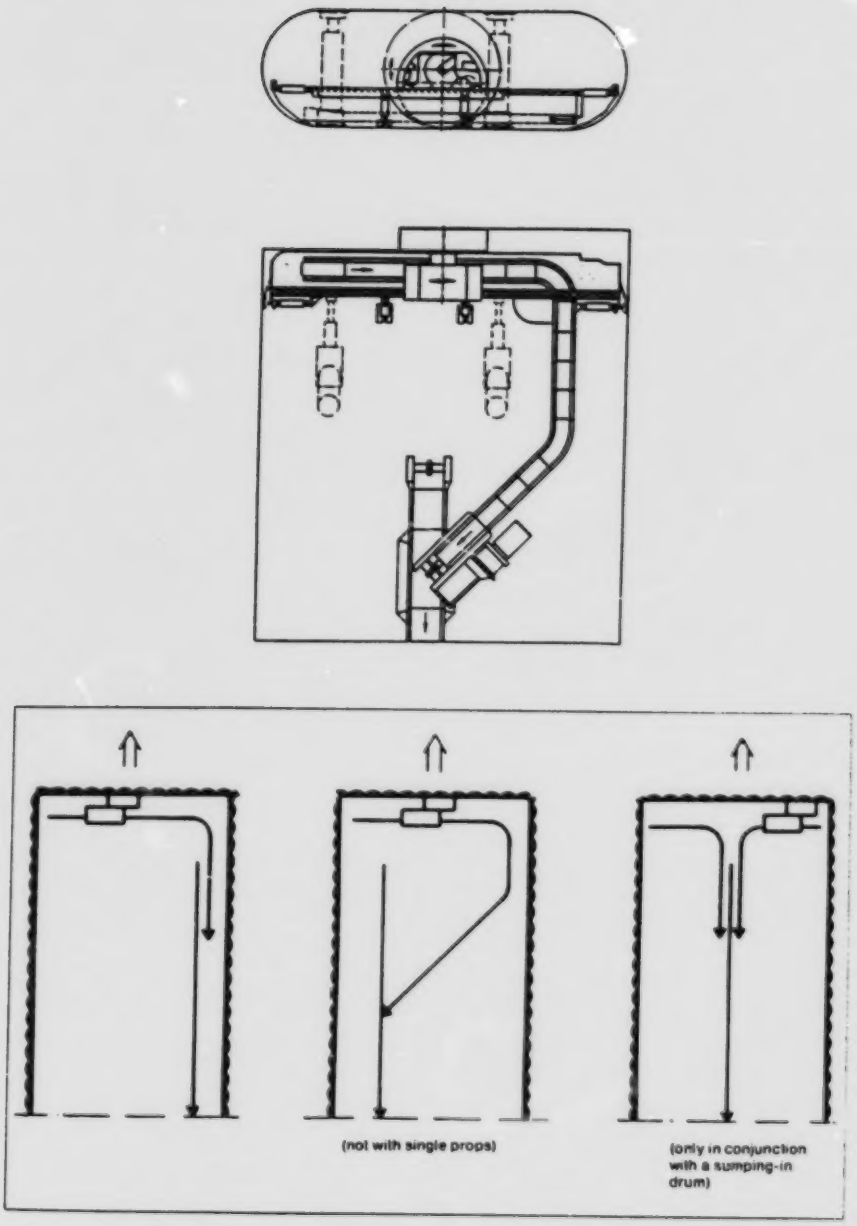
EICKHOFF ESA 60 CUTTING METLIOD (Source: Eickhoff)

FIGURE 4-62



EICKHOFF ESA 150-L MACHINE (Source: Eickhoff)

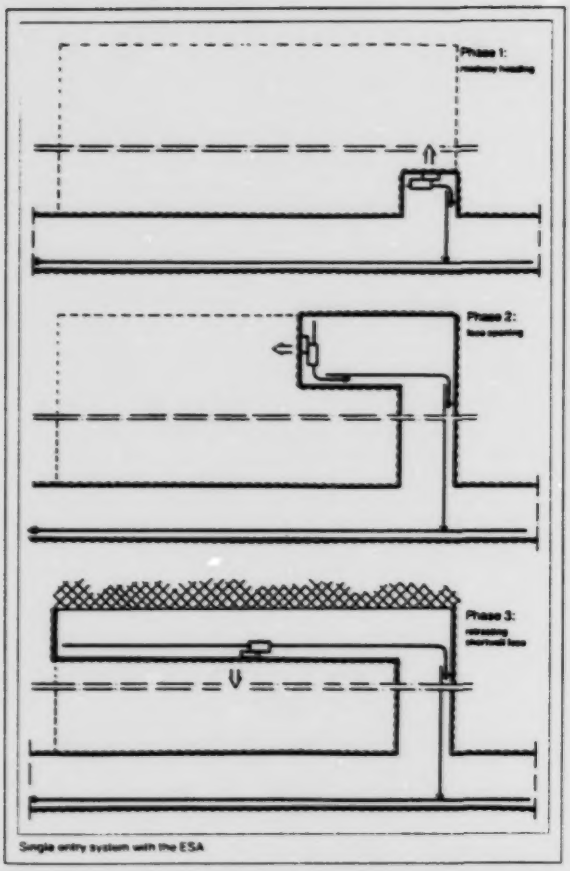
FIGURE 4-63

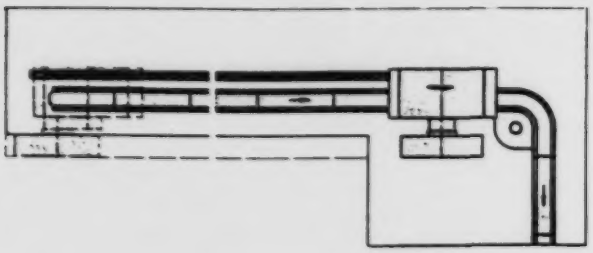


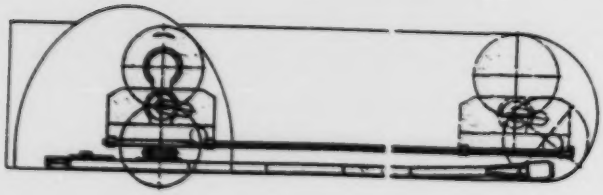
ROADWAY DRIVAGE WITH ESA MACHINE

FIGURE 4-64

(Source: Eickhoff



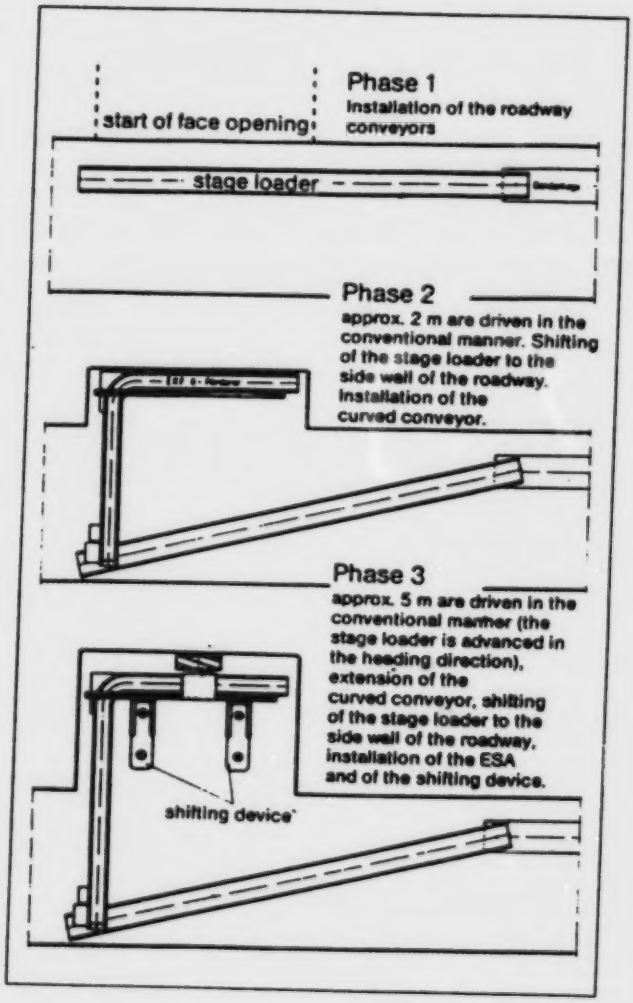




SINGLE ENTRY FACE WITH ESA MACHINE

(Source: Eickhoff)

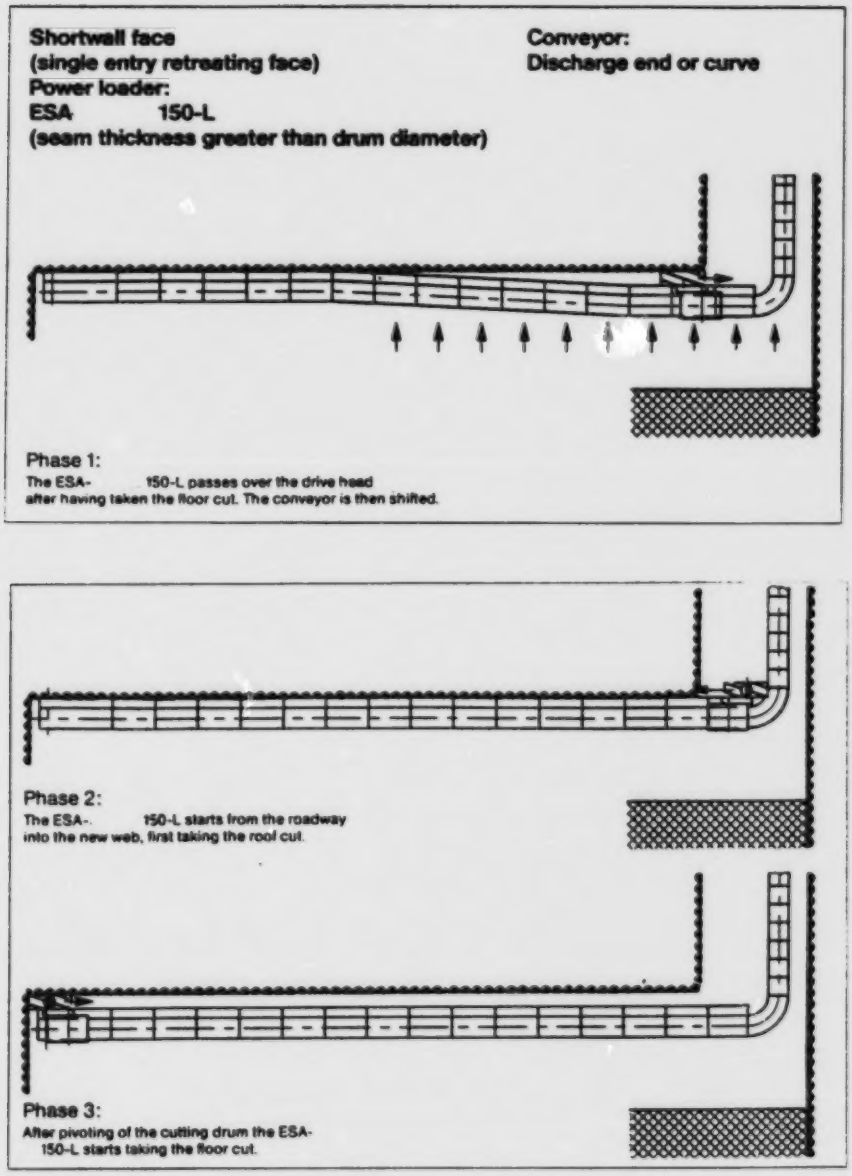
FIGURE 4-65



FACE DRIVAGE WITH ESA MACHINE

FIGURE 4-66

(Source: Eickhoff)



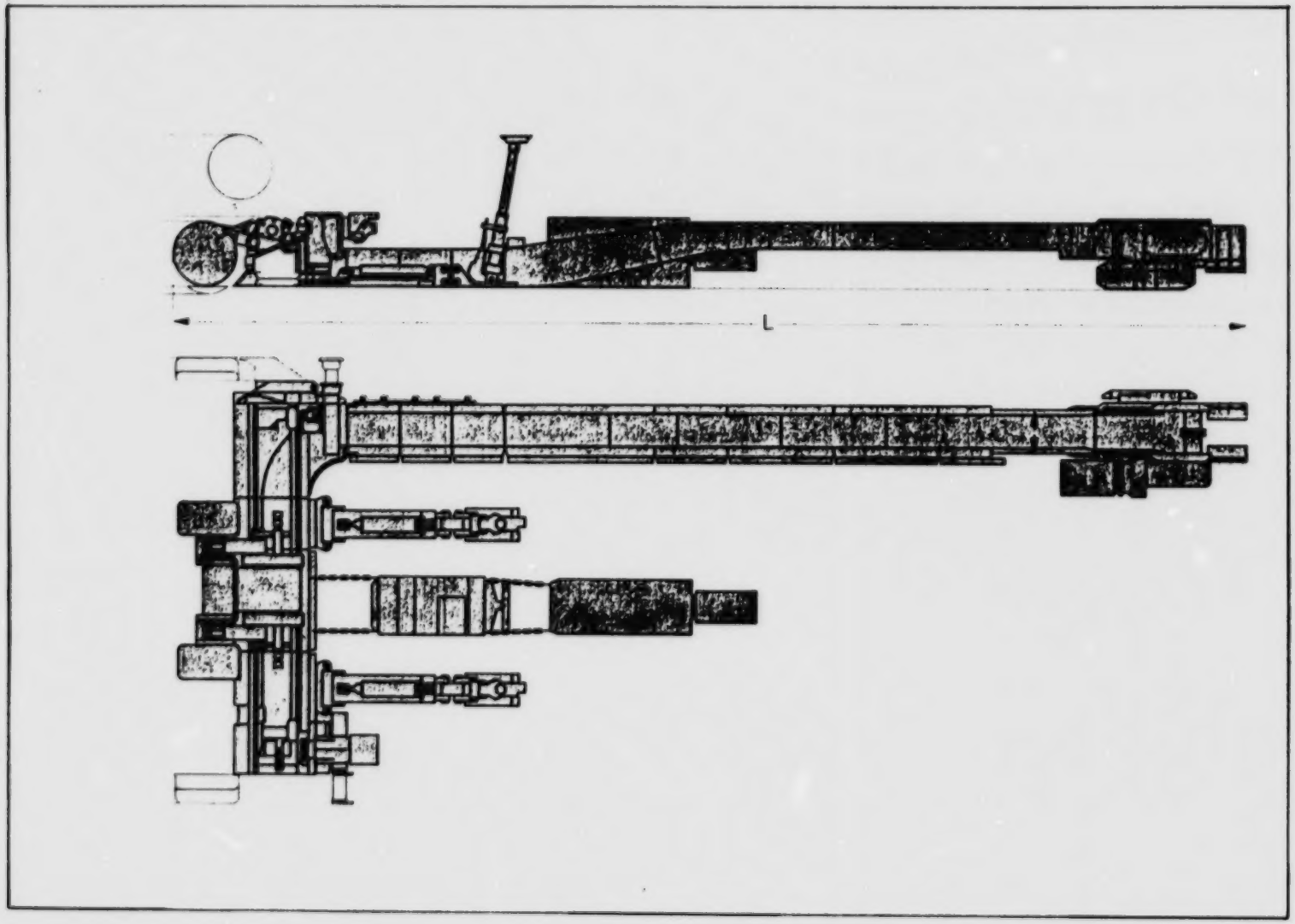
SINGLE ENTRY FACE SEQUENCE

(Source: Eickhoff)

FIGURE 4-67

WESTFALIA LÜNEN

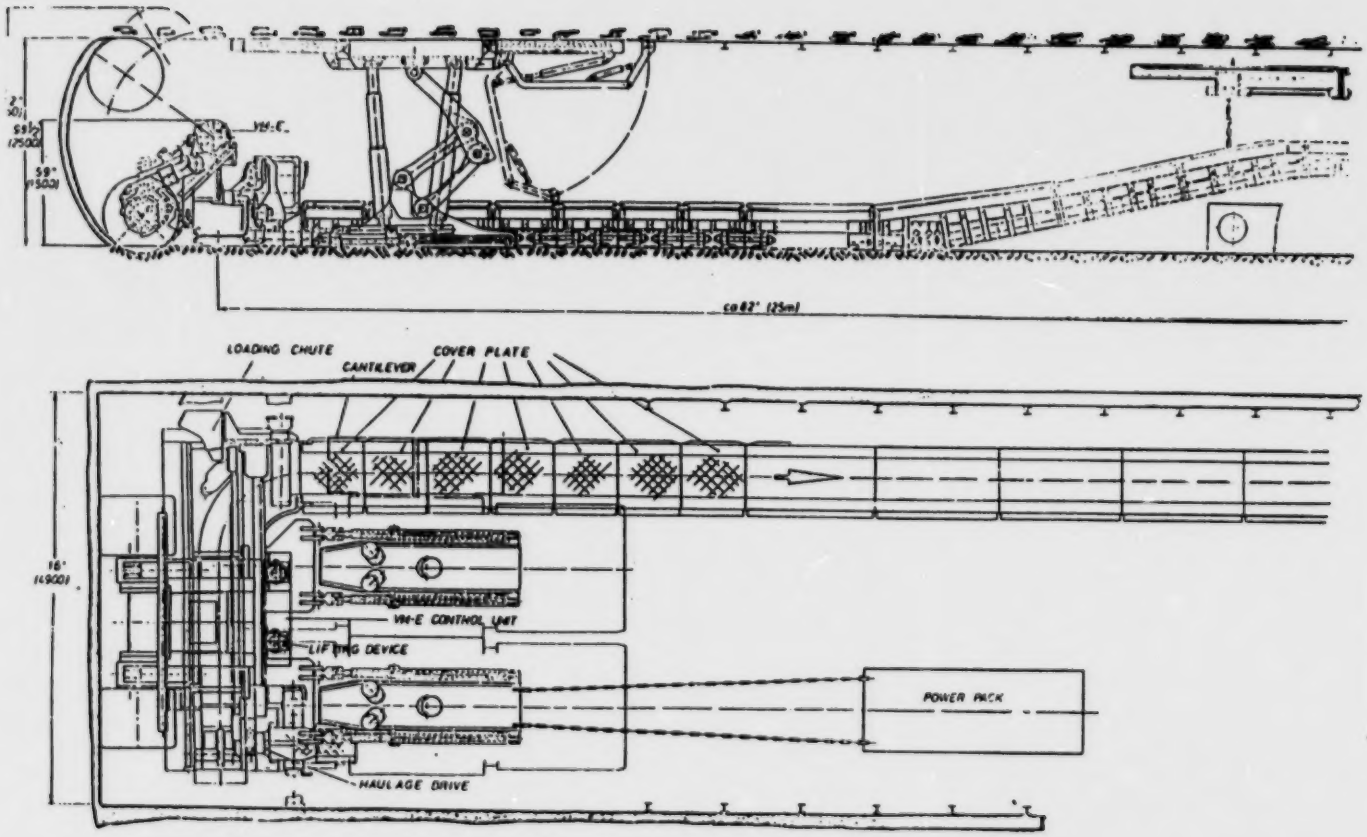
VM-E Heading and Mining System with hydraulic shifting devices and anchorage props



WESTFALIA VME MACHINE (STACKER JACKS)

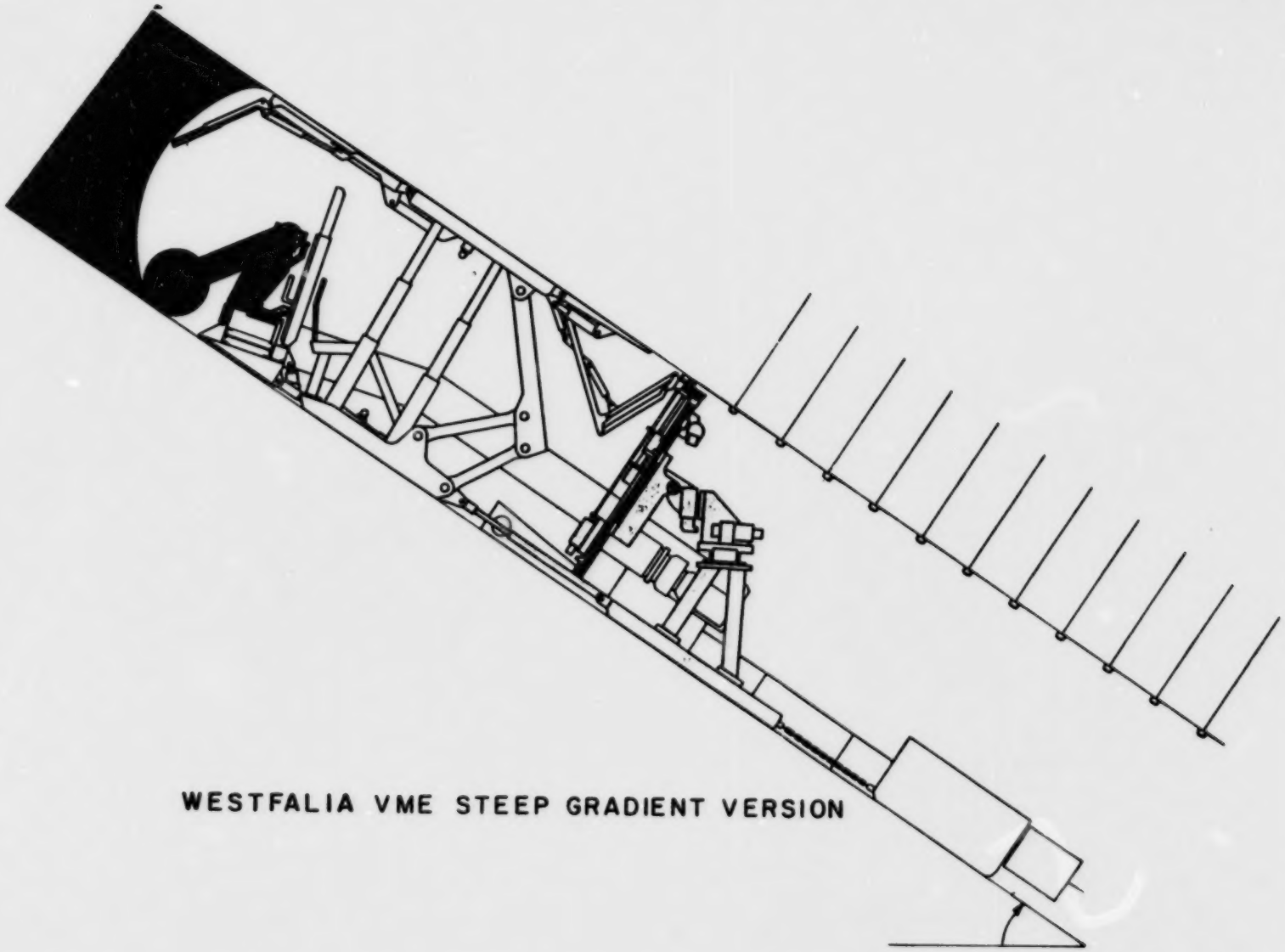
FIGURE 4-68

(Source: Westfalia)



WESTFALIA VME MACHINE (POWERED SUPPORTS) (Source: Westfalia)

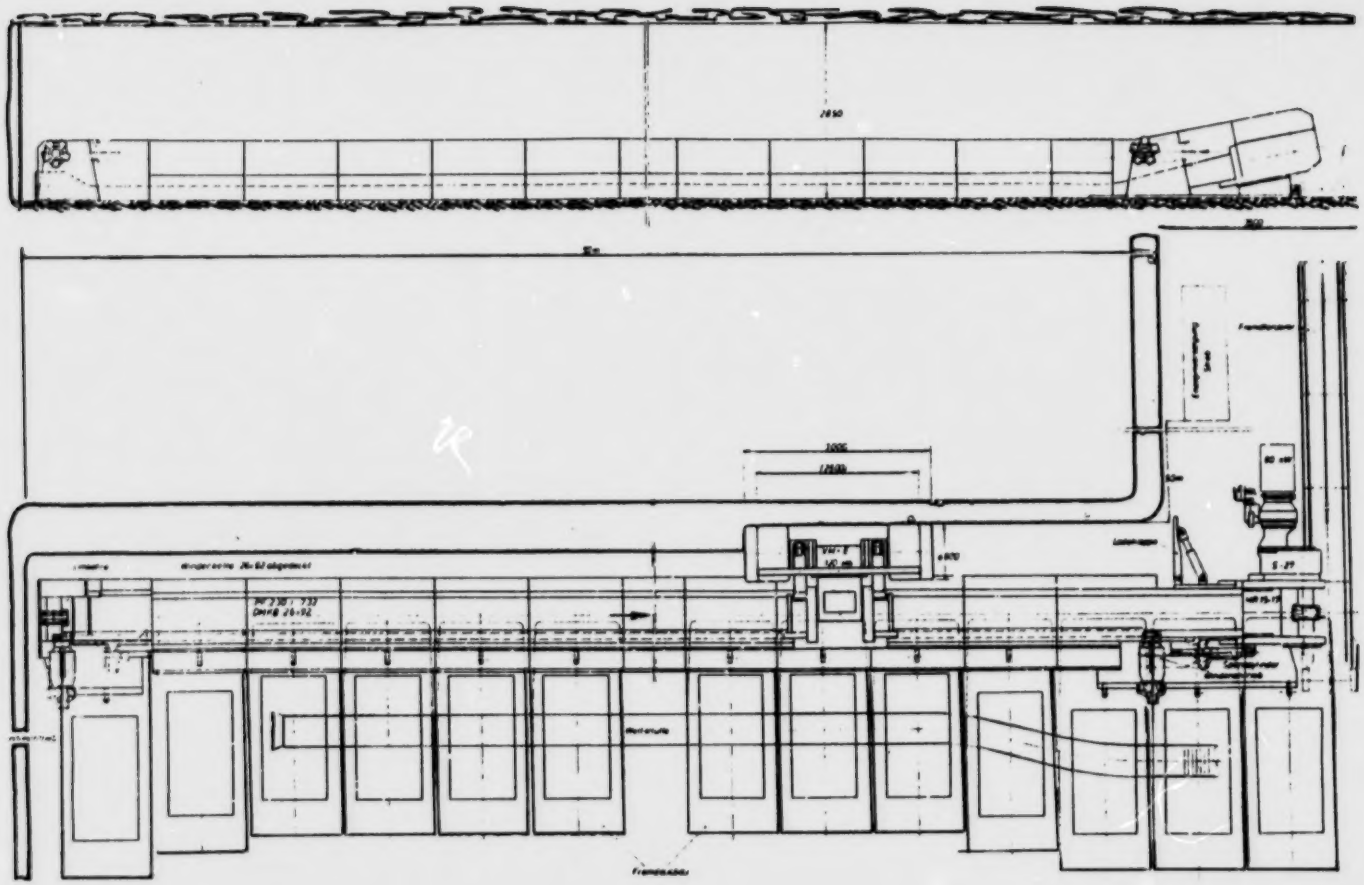
FIGURE 4-69



WESTFALIA VME STEEP GRADIENT VERSION

(Source: Westfalia)

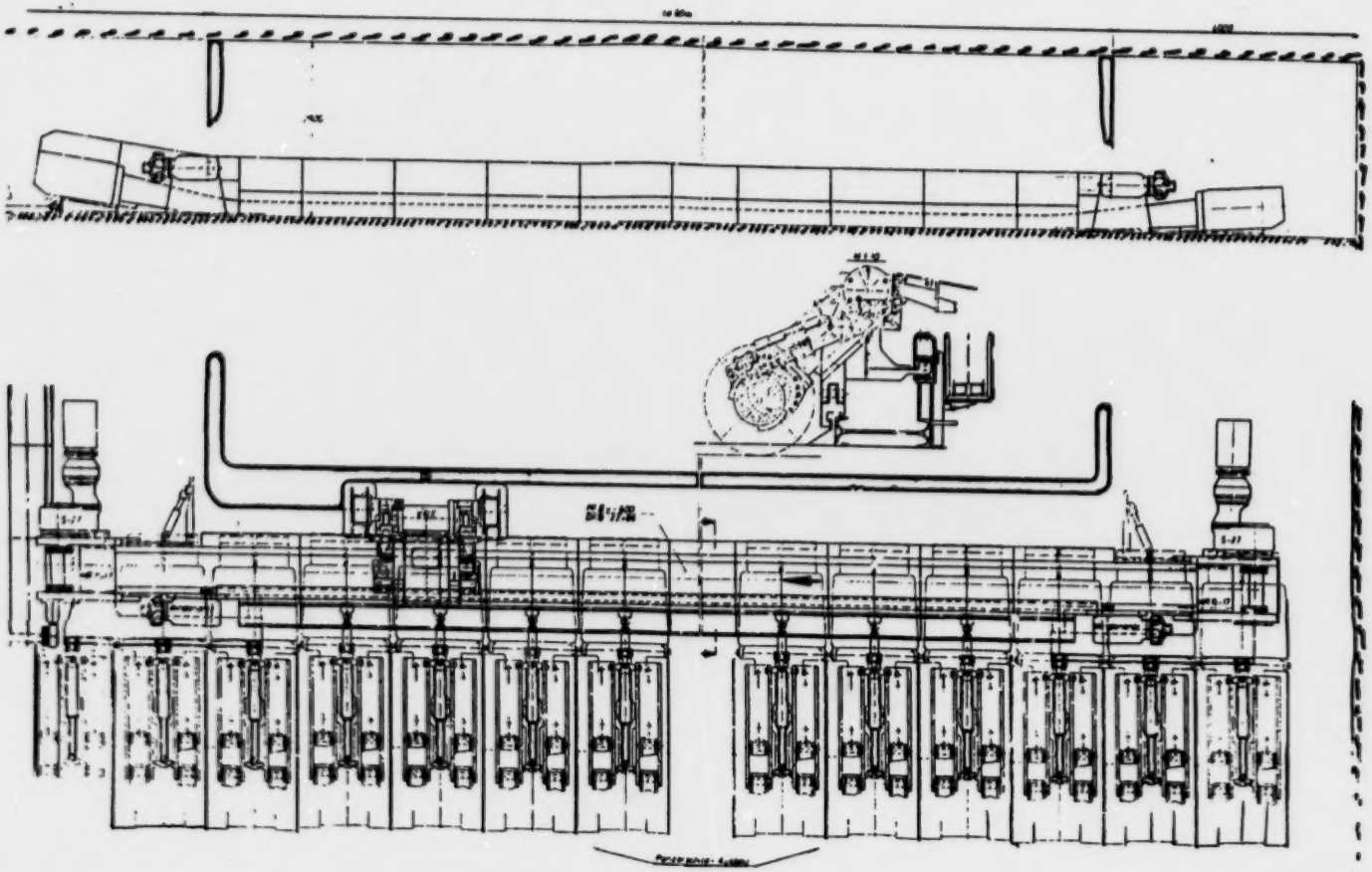
FIGURE 4-70



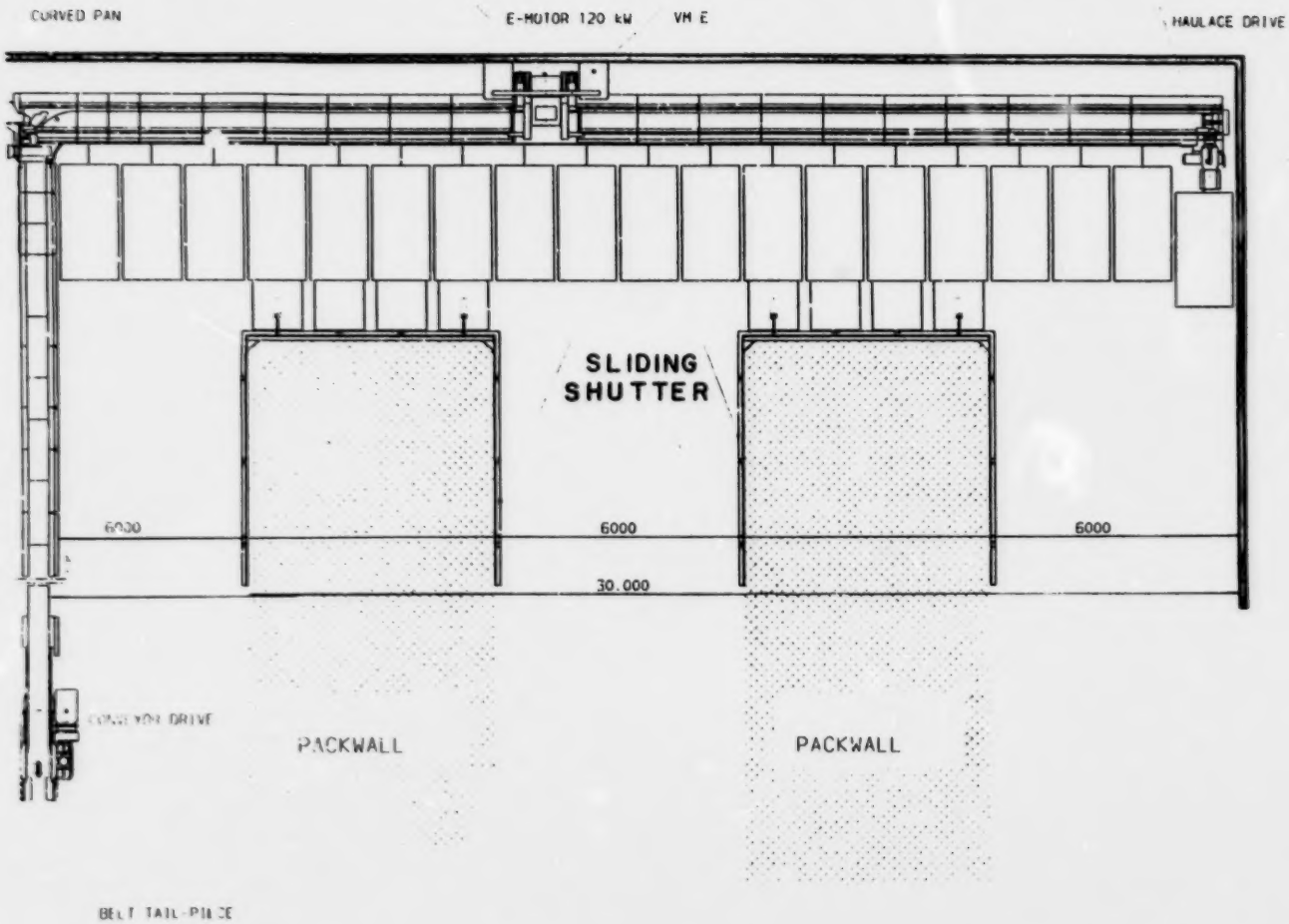
WESTFALIA VME SINGLE ENTRY FACE (HUNGARY) (Source: Westfalia)

FIGURE 4-71

FIGURE 4-72



WESTFALIA VME SHORTWALL FACE (MOROCCO) (Source: Westfalia)



WESTFALIA VME DEVELOPING MULTI ENTRY SYSTEM

(Source: Westfalia)

FIGURE 4-73

TABLE 4 - 1 SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

MINE Country Face		WISTOW UK A14	SHERWOOD UK 133	MANSFIELD UK 204	BEVERCOTES UK 99A	PYE HILL UK K49R	S. KIRKBY UK E08	MEASHAM UK 37	CADLEY HILL UK SE1	GRETLEY Australia M/1
NO. OF SINGLE ENTRY FACES WORKED		16	1	3	1	1	4	1	2	1
DATE SINGLE ENTRY FACE OPERATED		Aug/83 to date	May 87 to date	Jan 87 to date	1986	1983	1980	1982	1984	Start Jun 1988
GEOLOGY										
Depth of coal	(m)	310	600	665	-	-	415	130	-	75
Thickness of seam	(m)	2.4	3.4 (3.1 mined)	2.3	1.50	1.85	1.60	1.50	2.25	1.8 - 2.5
Dip of seam	(deg)	4	3	3	level	2	1.7	6.4	-	flat
Rock type - immediate roof		shale/siltstone	coaly shale	mudstone	-	-	-			-
- floor		mudstone	mudstone	siltstone	-	-	-			-
SINGLE ENTRY ROADWAYS										
Width	(m)	4.57	5.7	5.2	3.6	4.3	4.88	3.44	3.96	4.88
Height	(m)	2.44	3.1	2.9	2.8	2.4	1.98	2.44	2.13	2.2
Shape		rectangular	flat top arch	flat top arch	flat top arch	flat top arch	flat top arch	arch	flat top arch	rectangular
Area - ventilation	(m^2)	10	16.7	15	10	9	9.6	6.7	8.4	9.8
Maximum length	(m)	1000	1240	960	600	240	600	270	400	2000
Minimum length	(m)	700	-	450	-	-	-	-	-	-
Support - type		steel beam/legs	Hollybank 3 pc	Hollybank 3 pc	Hollybank 3 pc	Hollybank 3 pc	Hollybank 3-pc	3 pc arch	3 pc arch	rock bolt + strap
- spacing	(m)	0.9	1.0	1.2	1.0	1.07	0.91	0.9	0.91	1.5
Drivage method - M/C type		BJD Heliminer	Dosco Mk 2B	JCM 12	-	-	Dosco Dintheade	-	-	Jeffrey 1036
- power (cutting)			82	260	-	-	90	-	-	-
- coal removal		1.07m conveyor	1.2m conveyor	1.07 conveyor	-	-	conveyor	-	-	Shuttle car/CV
- ventilation					-	-		-	-	-
- fan	(kW)	90(F), 37.5(E)	2 x 37.5kW (F)	90 (F)	-	-	-	-	-	-
- ducting		lay flat	glass fibre	lay flat	-	-	-	-	-	-
- diameter	(m)	760	760	900	-	-	-	-	-	-
- volume	(m^3)	6.0	6.0 & 3.0	3.0 min	-	-	-	-	-	-
Performance - average week	(m)	150	90	55	-	-	-	-	-	-
- best week	(m)	170	100	82	-	-	-	-	-	-
- best shift	(m)	20	12	10.4	-	-	-	-	-	20
- manpower/shift		6	7	4	-	-	-	-	-	-

TABLE 4 - 1 SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

MINE		WISTOW	SHERWOOD	HANSFIELD	BEVERCOTES	PYE HILL	S. KIRKBY	HEASWAM	CADLEY HILL	GRETLEY
Country		UK	UK	UK	UK	UK	UK	UK	UK	Australia
Face		A14	133	204	99A	K49R	E08	37	SE1	NW1
SINGLE ENTRY FACE										
Geometry.										
· face length	(m)	35	55	45	60	14	35	50	45	36
· panel length	(m)	1000	1240	960	600	240	600	270	400	2000
· mining height	(m)	2.1	3.1	2.3	1.5	1.53	1.60	1.50	1.98	2.0
· entry height	(m)	2.44	3.1	2.3	2.8	2.40	1.98	2.44	2.25	2.2
· entry width	(m)	4.57	5.4	5.2	3.6	4.30	4.88	3.44	3.96	4.88
· top coal left	(m)	0.34	0.3	-	-	0.32	no	no	0.27	no
· rib pillar size	(m)	55	50	55	-	-	35	-	25	25
· panel pillar size	(m)	30	60	60	-	-	40	-	40	32
· mining remnant/virgin		virgin	virgin	virgin	remnant	remnant	remnant	remnant	remnant	virgin
· panel extraction	(%)	39	52	45	-	-	47	-	64	59
Equipment.										
· Mining Machine										
· model		AS500 DERDS	BJD 859 DERDS	AM17 DERDS	AM17 DERDS	DOSCO ISM 1530	AM SERDS	AB16 SERDS	BJD 859 DERDS	BJD ACE SERDS
· power	(kW)	300	225	202	202	90	150	149	150	300
· max. cutting speed	(m/min)	10	10	10	10	-	-	-	-	10
· haulage system		Racketrack	Racketrack	Racketrack	Racketrack	-	racketrack	racketrack	roll track	BJD Multirack
· drum dia.	(m)	1.68	1.68	1.65	1.52	-	1.37	1.15	1.37	1.5
· web depth	(m)	0.76	0.68	0.65	0.68	-	0.68	0.61	0.75	1.0
· pick speed	(m/s)					-	-	-	-	-
· special features		vent. drum PFF		RAC drum	FIDO arm	-	-	-	PFF	3 shoe w/frame
· AFC or Special c/v										
· headframe		Mining Supplies	NCB Spec.	Mining Supplies	NCB Spec	ISM flights	NCB Spec	NCB Spec	Neco Curved AFC	Halbach & Braun EKF2 Curved AFC
· gearbox		Winster 90 deg	Winster 90 deg	Mining Supplies	NCB Spec	-	NCB Spec	NCB Spec	in line	in line
· power	(kW)	112	120	150	112	-	48	67	112	160
· chain	(mm)	2 x 22 O/B	2 x 22 I/B	2 x 22 I/B	2 x 19 O/B	-	2 x 19 O/B	2 x 19 O/B	1 x 26 I/B	1 x 30 I/B
· furnishings		Pitcraft	Pitcraft	Pitcraft	Pitcraft	-	Pitcraft	Pitcraft	Pitcraft	std
· features		coal sizer 0.28 m^2 duct	0.29 m^2 duct	0.30 m^2 duct	0.27m^2 duct	-	0.26m^2 duct	no steel duct	0.2 m^2 duct	-
· Stage Loader										
· type		Beam	Beam	Beam	Beam	ISM conveyor	Beam	Beam	Curved AFC	(as above)
· length	(m)	23	30	25	-	-	-	10m overlap	67.5 total	60m length 20m in gate
· drive		direct	direct	-	NCB Spec	-	-	NCB Spec	(22.5m in gate)	-
· power	(kW)	112	120	112	112	-	48	49	-	-
· chain		2 x 22 O/B	2 x 22 O/B	2 x 19 O/B	2 x 19 O/B	-	2 x 19 O/B	2 x 19 O/B	-	-
· furnishings			coal sizer	coal sizer	-	-	-	-	90 dg rollcurve	112 kW coal sizer
· Powered Supports (Face)										
· type		Dowty 4 x 450t chock shields	Gullick 4x370t chock shields	Dowty 4x325t chock shields	Gullick 6x240t chocks	Dowty 6x240t chocks	GD 5 leg 200t shields	Dowty 4 leg 203t shields	Dowty 4leg 280t chock shield	Dowty 2 leg 400t Sealed shields
· model										
· centres		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.0
· power pack		Gullick remote	Hauhinco remote	Gullick remote	Gullick local	-	remote	Gullick remote	Gullick remote	local
· control system		Dowval	manual adjacent	Bi-di adjacent	-	-	-	-	Electrohydraulic	Electro-hydraulic
· auxilliary support		face sprags	face sprags	hydr. forepoles	-	-	-	-	-	-

TABLE 4 - 1 SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

MINE		WISTOW	SHERWOOD	MANSFIELD	BEVERCOTES	PYE HILL	S. KIRKBY	MEASHAM	CADLEY HILL	GRETLEY
Country		UK	UK	UK	UK	UK	UK	UK	UK	Australia
Face		A14	133	204	99A	K498	E08	37	SE1	MW1
SINGLE ENTRY FACE										
			blind end plate							
· Powered Supports (Roadhead)										
· type		Dowty 4 x 280t chock shields	Dowty 4 x 280t chock shields	Dowty 4 x 325t chock shields	Gullick 5 x 325t chocks	Dowty chocks Desford 4 I/L	Gullick 1-8 leg anchor 2-9 leg chocks	Dowty 4 x 203t 4 in line	Dowty 4 x 280t chock shields (2)	Dowty 2 leg 400t shields
· model		3	2	3	2	2Dowty+1Desford		1	1 + 2leg 60t ext	2
· number								at roadside	1 + 2leg 30t ext	-
· features		ext. canopies	ext. cantilever	ext. cantilever	-	sliding chocks w/	SMRE canopy			
Ventilation.										
· primary fan	(kW)	90(F)	90 (F)	90 (F)	90 (F)	37 (F)	90 (F)	37 (E)	37 (E)	none
· secondary fan	(kW)	90(F)	2 X 37.5 (F)	37.5 (F)	37.5 (F)	4(F)	11 (F)	19 (F)	37 (F)	none
· ventilation primary	(m^3/s)	6.5	6.0 (5.0 min)	6.0 (5.0 min)	7.0	5.0	6.5	3.0 min	6.5	air returns
· ventilation secondary	(m^3/s)	2.5	3.5	4.0	4.5	3.0	2.0	2.0 min	2.0	through goaf
· ventilation face	(m^3/s)	4.5 min.	3.0 min	3.0 min	3.5 min	3.0	2.0	2.0 min	2.0	-
· methane emission	(m^3/s)	0.40	0.04	0.011	0.020	-	low	low	low	low
· safety features										
· methane monitor		BM1	BM3	BM1 & BM3	BM3	BM1	BM1	BM1	BM1	not known
· air flow monitor		TX130	BA5	BA5	BA5	TX130	BA4	TX140	TX130	not known
· CO detector		yes	yes	yes	yes	yes	yes	yes	yes	not known
· smoke detector		yes	yes	yes	yes	yes	yes	yes	yes	not known
· fan vibration		yes	yes	yes	yes	yes	yes	yes	yes	-
Manpower (Shift).										
· face machine		2	2	2	-	2	2	1	2	2
· supports		1	2	1	-	1	2	3	3	1
· stage loader/consol		1	1	1	-	1	1	1	1	1
· supervision		1	1	1	-	1	1	1	1	1
· maintenance (E)		0.5	0.5	0.5	-	1	0.5	1	1	1
· maintenance (M)		0.5	0.5	0.5	-	1	0.5	1	1	1
· supplies		0.6	1	-	-	-	-	-	-	-
· other		-	-	-	-	-	-	-	-	-
Performance.										
								(1 shift)		
· average advance/week	(m)	150	-	62.6	-	34 (5 shifts)	23.2	-	30	40 - 60 (est)
· best advance/week	(m)	180	90	92.2	-	-	-	-	-	-
· avge tonnes/week	(t)	22500	-	5461	-	984	1380	730	6000	-
· best tonnes/week	(t)	26928	8000	8039	-	1445	1777	1100	-	-
· avge tonnes/shift	(t)	1500	-	429	-	197	-	-	1200	-
· OMS (t) average	(t/MS)	240	120	84.5	-	24.6	16.3	16.4	57.1	-

TABLE 4 - 1 SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

MINE		WISTOW	SHERWOOD	MANSFIELD	BEVERCOTES	PYE HILL	S. KIRKBY	HEASMAN	CADLEY HILL	GRETLEY
Country		UK	UK	UK	UK	UK	UK	UK	UK	Australia
Face		A14	133	204	99A	K49R	E08	37	SE1	MW1
COAL CLEARANCE										
· Gate Conveyor · type		FSW Modular	FSW Modular	FSW Modular	-	FSW Lion	Hunwood	-	-	Fox In Seam
· width	(m)	1.07	1.2	1.07	-	0.91	0.91	-	-	1.05
· speed	(m/s)	2.5	2.4	2.1	-	-	-	-	-	
· capacity	(tph)	1000	1100	1080	-	-	-	-	-	800
· length	(m)	1050	1240	900	-	-	-	-	-	2070
· rise/(fall)	(m)				-	-	-	-	-	0
· power	(kW)	112	112	112	-	-	-	-	-	225
· LTU storage	(m)	100	96	50	-	-	-	-	-	168
MATERIALS SUPPLY										
· Equipment used		diesel loco battery loco flat bed cars	diesel loco flat bed cars	GD MP100 FSV	-	-	-	-	-	FSV
FACE INSTALLATION/RECOVERY/TRANSFER										
· Elapsed time · installation		1 week	2 weeks	42 shifts	-	-	-	-	-	-
· recovery/transfer		1 week	est. 2 weeks	42 shifts	-	-	-	-	-	Estimated 3 days
· Equipment used · face supports		Eimco 913 FSV	Eimco 913 FSV	FSV	-	-	-	-	-	FSV
· other		locomotive	locomotive	FSV	-	-	-	-	-	FSV
REGULATORY LIMITATIONS										
· Special conditions		specific monitoring	specific monitoring	specific monitoring	specific monitoring	specific monitoring	specific monitoring	specific monitoring	specific monitoring	not known
· Exemptions		12 man limit	9 man limit	9 man limit 18 man exemptio	9 man limit 18 man exemption	12 man limit	9 man limit	not known	not known	not known
FACE/DISTRICT PERFORMANCE										
· Revenue ($/t)	($/t)			104.20	-	-	80.77	-	-	-
· Operating Cost ($/t)	($/t)							-	-	-
· Labour	($/t)		-	3.10	-	73.6	18.80	-	-	-
· Materials	($/t)		-	0.67	-	18.4	10.50	-	-	-
· Power	($/t)		-	0.35	-	-	1.80	-	-	-
· Other	($/t)		-	5.73	-		5.60	-	-	-
· Total	($/t)		-	9.85	-	92.0	36.7	-	-	-

TABLE 4 - 1 SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

MINE Country Face		STOLZENBACH W. Germany #21	RHEINLAND W.Germany NG1	OCP #14 Morocco -	MORGRAD Hungary -	WHITJICK UK -	ALLERTON BYWATER UK -	WATH UK -	ROYSTON DRIFT UK -	LEDSTON LUCK UK -
NO. OF SINGLE ENTRY FACES WORKED		22	(2)	1	(1)	several	1+	1	1	1
DATE SINGLE ENTRY FACE OPERATED		1982 to present	Proposed	1985	June 1988	1980 - 85	current	1980	1983	1983
GEOLOGY										
Depth of coal	(m)	160	730	-	-	-	-	-	-	-
Thickness of seam	(m)	3.5 - 5.0	1.95	2.85	2.85	-	-	-	-	-
Dip of seam	(deg)	-	3	-	-	-	-	-	-	-
Rock type - immediate roof		Hard clay	-		-	-	-	-	-	-
- floor		-	-		-	-	-	-	-	-
SINGLE ENTRY ROADWAYS										
Width	(m)	3.4	5.8	-	3.50	-	-	-	-	-
Height	(m)	3.3	4.0	-	2.85	-	-	-	-	-
Shape		Trapezoidal	Arch	-	rectangular	-	-	-	-	-
Area - ventilation	(m^2)	10	18	-	10.0	-	-	-	-	-
Maximum length	(m)	500	600	-	-	-	-	-	-	-
Minimum length	(m)	260	-	-	-	-	-	-	-	-
Support - type		3 pc steel	4 pc steel	-	-	-	-	-	-	-
- spacing	(m)	-	-	-	-	-	-	-	-	-
Drivage method - M/C type		-	-	-	-	-	-	-	-	-
- power (cutting)		-	-	-	-	-	-	-	-	-
- coal removal		-	-	-	-	-	-	-	-	-
- ventilation		-	-	-	-	-	-	-	-	-
- fan	(kW)	-	-	-	-	-	-	-	-	-
- ducting		-	-	-	-	-	-	-	-	-
- diameter	(m)	-	-	-	-	-	-	-	-	-
- volume	(m^3)	-	-	-	-	-	-	-	-	-
Performance - average week	(m)	-	-	-	-	-	-	-	-	-
- best week	(m)	-	-	-	-	-	-	-	-	-
- best shift	(m)	-	-	-	-	-	-	-	-	-
- manpower/shift		-	-	-	-	-	-	-	-	-

TABLE 4 - 1 SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

MINE		STOLZENBACH	RHEINLAND	OCP #14	NORGRAD	WHITWICK	ALLERTON BYWATER	WATH	BOYSTON DRIFT	LEDSTON LUCK
Country		W. Germany	W.Germany	Morocco	Hungary	UK	UK	UK	UK	UK
Face		#21	HG1	-	-	-	-	-	-	-
SINGLE ENTRY FACE										
Geometry.										
· face length	(m)	50	33	26	50	-	50	7	40	40
· panel length	(m)	500	600	-	-	-	-	-	-	-
· mining height	(m)	3.3	1.95	2.85	2.85	-	-	-	-	-
· entry height	(m)	3.3	4.0	-	2.85	-	-	-	-	-
· entry width	(m)	3.4	5.8	-	3.50	-	-	-	-	-
· top coal left	(m)	no	no	-	no	-	-	-	-	-
· rib pillar size	(m)	not known	-	-	-	-	-	-	-	-
· panel pillar size	(m)	not known	-	-	-	-	-	-	-	-
· mining remnant/virgin		virgin	remnant	virgin	virgin	-	-	-	-	-
· panel extraction	(%)	not known	-		-	-	-	-	-	-
Equipment.										
· Mining Machine										
· model		Eickhoff ESA60L	Eickhoff ESA150	Westfalia VME	Westfalia VME	Dosco ISM	AM500 DERDS	AM SERDS	AM DERDS	-
· power	(kW)	60	150	120	120	-	-	-	-	-
· max. cutting speed	(m/min)	9	-	20	20	-	-	-	-	-
· haulage system		Eicotrack	Eicotrack	chain	chain	-	-	-	-	-
· drum dia.	(m)	1.60	1.05	0.9	0.9	-	-	-	-	-
· web depth	(m)	0.625	0.75	-	-	-	-	-	-	-
· pick speed	(m/s)	-	-	3.1	3.1	-	-	-	-	-
· special features		PFF	PFF	-	-	-	-	-	-	-
· AFC or Special c/v		Halbach & Braun	Eickhoff EKF2							
· headframe		curved AFC	std	Westfalia PF230	Westfalia PF230	-	-	-	-	-
· gearbox		EKF2	std	-	-	-	-	-	-	-
· power	(kW)	200	-	-	-	-	-	-	-	-
· chain	(mm)	1 x 30 I/B	1 x 26 I/B	-	-	-	-	-	-	-
· furnishings		Standard	std	-	-	-	-	-	-	-
· features		Roller curve	spillage c/v	-	-	-	-	-	-	-
· Stage Loader			none							
· type		(as above)	AFC	-	-	-	-	-	-	-
· length	(m)	82m total	loads	-	-	-	-	-	-	-
· drive		in line	direct	-	-	-	-	-	-	-
· power	(kW)	-	onto	-	-	-	-	-	-	-
· chain		-	belt	-	-	-	-	-	-	-
· furnishings		-	conveyor	-	-	-	-	-	-	-
· Powered Supports (Face)						-	-	-	-	-
· type		Hemscheidt 2 leg	Kloechner	-	-	-	-	-	-	-
· model		490t shields	2 leg shields	-	-	-	-	-	-	-
· centres		1.5	1.5	-	-	-	-	-	-	-
· power pack		Hauhinco remote	remote	-	-	-	-	-	-	-
· control system		pilot	-	-	-	-	-	-	-	-
· auxiliary support		blind end sides	props & bars	-	-	-	-	-	-	-

TABLE 4 - 1 SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

MINE Country Face		STOLZENBACH W. Germany #21	RHEINLAND W.Germany HG1	OCP #14 Morocco	MORGRAD Hungary	WHITWICK UK	ALLERTON BYWATER UK	WATH UK	ROYSTON DRIFT UK	LEDSTON LUCK UK
SINGLE ENTRY FACE			at roadside							
· Powered Supports (Roadhead)										
· type		Hemscheidt 2leg	none	-	-	-	-	-	-	-
· model		G490 SHIELDS	prope & link	-	-	-	-	-	-	-
· number		2	bars - 4 rows	-	-	-	-	-	-	-
· features		1.5M ext canopy	-	-	-	-	-	-	-	-
Ventilation.										
· primary fan	(kW)	not known	24 + comp. air	-	-	-	-	-	-	-
· secondary fan	(kW)	not known	-	-	-	-	-	-	-	-
· ventilation primary	(m^3/s)	not known	10	-	-	-	-	-	-	-
· ventilation secondary	(m^3/s)	not known	-	-	-	-	-	-	-	-
· ventilation face	(m^3/s)	flexiduct	10	-	-	-	-	-	-	-
· methane emission	(m^3/s)	non-gassy	non gassy	-	-	-	-	-	-	-
· safety features		not known		-	-	-	-	-	-	-
· methane monitor		not known	yes	-	-	-	-	-	-	-
· air flow monitor		not known	yes	-	-	-	-	-	-	-
· CO detector		not known	yes	-	-	-	-	-	-	-
· smoke detector		not known	not known	-	-	-	-	-	-	-
· fan vibration		not known	not known	-	-	-	-	-	-	-
Manpower (Shift).										
· face machine		1	2	-	-	-	-	-	-	-
· supports		2	2	-	-	-	-	-	-	-
· stage loader/consol		2	1	-	-	-	-	-	-	-
· supervision		1	1	-	-	-	-	-	-	-
· maintenance (E)		1	1	-	-	-	-	-	-	-
· maintenance (M)		1	1	-	-	-	-	-	-	-
· supplies		-	-	-	-	-	-	-	-	-
· other		-	4	-	-	-	-	-	-	-
Performance.										
· average advance/week	(m)	45.0	75 (E)	160	-	-	-	-	-	-
· best advance/week	(m)	51.5	-	-	-	-	-	-	-	-
· avge tonnes/week	(t)	7800	10500 (E)	14255	-	-	-	-	-	-
· best tonnes/week	(t)	8900	-	-	-	-	-	-	-	-
· avge tonnes/shift	(t)	920	700 (E)	-	-	-	-	-	-	-
· OMS (t) average	(t/MS)	88	58 (E)	69	-	-	-	-	-	-

TABLE 4 - 1 SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

MINE Country Face		STOLZENBACH W. Germany #21	RHEINLAND W.Germany NG1	OCP #14 Morocco	MORGRAD Hungary	WHITWICK UK	ALLERTON BYWATER UK	WATH UK	ROYSTON DRIFT UK	LEDSTON LUCK UK
COAL CLEARANCE										
· Gate Conveyor · type		-	-	-	-	-	-	-	-	-
· width	(m)	0.8	-	-	-	-	-	-	-	-
· speed	(m/s)	2.5	-	-	-	-	-	-	-	-
· capacity	(tph)	-	-	-	-	-	-	-	-	-
· length	(m)	-	-	-	-	-	-	-	-	-
· rise/(fall)	(m)	-	-	-	-	-	-	-	-	-
· power	(kW)	-	-	-	-	-	-	-	-	-
· LTU storage	(m)	-	-	-	-	-	-	-	-	-
MATERIALS SUPPLY										
· Equipment used		-	-	-	-	-	-	-	-	-
FACE INSTALLATION/RECOVERY/TRANSFER										
· Elapsed time · installation		12 - 14 days	-	-	-	-	-	-	-	-
· recovery/transfer		incl rec/transfe	-	-	-	-	-	-	-	-
· Equipment used · face supports		diesel monorail	-	-	-	-	-	-	-	-
· other		diesel monorail	-	-	-	-	-	-	-	-
REGULATORY LIMITATIONS										
· Special conditions		not known	Very stringent on methane	-	-	-	-	-	-	-
· Exemptions		not known	none	-	-	-	-	-	-	-
FACE/DISTRICT PERFORMANCE										
· Revenue ($/t)	($/t)	-	-	-	-	-	-	-	-	-
· Operating Cost ($/t)	($/t)	-	-	-	-	-	-	-	-	-
· Labour	($/t)	-	-	-	-	-	-	-	-	-
· Materials	($/t)	-	-	-	-	-	-	-	-	-
· Power	($/t)	-	-	-	-	-	-	-	-	-
· Other	($/t)	-	-	-	-	-	-	-	-	-
· Total	($/t)	-	-	-	-	-	-	-	-	-

TABLE 4-2

A14 SINGLE ENTRY RETREAT FACE - WISTOW MINE

Depth of Cover	310 m
Seam Height	2.4 m
Seam Height Mined	2.1 m
Face Length	35 m
Panel Length	1000 m
Pillar Width	55 m
Gradient	Approximately level to 1 in 14
Roadway Width	5 m
Shearer	- Anderson Strathclyde AM500 DERDS. (300 kW) - Pitcraft haulage - 0.76 web - 1.68 m dia. drum with pickface flushing and venturi ventilation - Forward attack picks plus heavy duty radial picks on back face of drum - Powered cowls - Fully outboard 1.3 m ranging arms - Pitcraft water boost pump to give 7 Mpa (1000 psi) (Fire range at 3 Mpa) - Lindley Hydraulic tank for shearer on stage loader and oil piped along face to shearer - Cutting speed 9.8 m/min - M/c cutting on wedge from end to end - Perard Cable Handler
AFC	- 118 kW 2 speed, Head End Drive, Winster 90° Gearbox with integral chain tension and goaf side chain drive to coal sizer on face AFC - Mining Supplies 9 m radius Gemini ramped drive frame - Non driven return end - Twin outboard 22 mm chain with flight bars at 0.5 m spacing - Heavy duty underplated line pans welded (including furnishings) in sets of 3 - Spill plates (1 m high) including Pitcraft ventiliation duct (0.28 m^2)
Stage Loader	- Beam type, 23 m long - 112 kW in-line Drive, direct drive (no fluid coupling)

TABLE 4-2 (Cont'd)

A14 SINGLE ENTRY RETREAT FACE - WISTOW MINE

	- H.D. return end bolted to same base plate as AFC drive to maintain delivery position and assist advance - Twin outboard chain with flights at 0.65 m centres - UMM chain tensioner - 0.6 m high beam plates - No overlap with gate conveyor - fixed delivery position, articulation only
Face Supports	- Dowty 4 x 450 t chock shields (22) with push button electro-hydraulic control at 1.5 m spacing - Gullick Dobson (2) Power packs remotely situated in intake with 50 mm intake and 64 mm return flexible hoses down gate to face supports - Face sprags fitted to chocks
Roadway Support	- 0.15 m x 0.15 m RSJ + 2 legs (pin jointed) meshed and strutted at 0.9 m centres + rock bolts - Powered supports at Roadhead, 3-Dowty 4 x 280 t chock shields with extended canopies
Gate Conveyor	- FSW Modular In-Seam Conveyor - Automatic Loop take-up (100 m belt) and Beltreel Station - PIAB belt tensioner set at max. 2 t, min. 1.2 t - Integral tail end receiving section - U trough, no rollers with four side staking rams to position in roadway for belt alignment - Conveyor controlled and tension monitored from surface - 1.06 m wide belt
Power	- Twin 1100v power supplies, 1 to shearer, 1 to AFC, stage loader and inbye fan - Transformers outbye in main roadway - Twin contactor gate end boxes, control console and booster fan mounted on stage loader so automatically moved with stage loader

TABLE 4-2 (Cont'd)

A14 SINGLE ENTRY RETREAT FACE - WISTOW MINE

Ventilation	- Two auxiliary systems, Primary to face ducting & blind end, Secondary to rear of roadhead chock.
	- Primary, 90 kW Engart forcing fan in outbye intake through 760 mm lay flat ducting to 37.5 kW Engart fan on stage loader to lay flat through ventilation duct through face to blind end. 'Rocket' tube at stage loader fan to collect ducting as face retreats.
	- Secondary, 90 kW Engart forcing fan in outbye intake through 610 mm lay flat ducting to rear of roadway powered support.
	- Primary 6m^3/s.
	- Secondary 2.5 m^3/s.
	- Monitors -
	  - Flow in blind end - TX 130 Alarms at less than 4.5 m^3/s.
	  - BM1 at #7 Chock - Alarm 0.8% CH_4 Power Cut off at 1.25% CH_4.
	  - Manual Reset
	  - BM1 at outbye end of roadway.
	  - CO monitor (10 ppm alarm via MINOS)
	  - Smoke detector end of roadway.
	  - Fan Vibration
	- Methane Emission 6-7 m^3/t.

Materials Handling	- Battery or diesel locomotive with Pikrose flatbed material cars.
Face Manpower/Shift	- Shearer 2 Supports/Rams 1 Face End 1 Supervision 1 5 Mechanic and Electrician on call. Manpower Limit 12.
Performance	- Face retreats 150 m/week on average. - 20 strips/shift average (1500 t ROM). - Max 27 strips in 1 shift. - Best week (A10's) 26,928 t. - Face OMS - 240 t. - Cost per tonne - $1.95 to $3.20/GJ

TABLE 4-2 (Cont'd)

A14 SINGLE ENTRY RETREAT FACE - WISTOW MINE

Installation/Salvage	- Face change 2 weeks.
	- Installation using loco transport - 1 week.
	- Pre salvage, face bolted & meshed.
	  - 6 rows - 2 m long bolts at 0.9 m intervals.
	  - Set with 2 Gopher machines at 40/hr.
	- EIMCO 913 FSV used to drag supports off face.
	- Face Support preparation 2 days.
	- Face Support removal 1 day.
	- Salvage - total 1 week.

TABLE 4-3

A15 SINGLE ENTRY DEVELOPMENT - WISTOW MINE

Depth of Cover	305 m.
Heading Height	2.44 m.
Heading Width	4.57 m.
Heading Length	1000 m.
Gradient	Level.
Roadway Support	- Hollybank Rectangular 150 mm x 150 mm R5J + 2 legs (pinpointed) at 0.9 m spacing lagged with wire mesh. - Row of 6 - 1.8 m full column resin 24 mm rebar bolts set between girder settings. 4 vertical bolts at 1 m centres 2 angled (30°) bolts, 1 over each side. Fitted with plates. - Drilled with compressed air 'Gopher' stoper behind Heliminer - Immediate roof 1.2 m fossilized shale. 1.8 m weak shale. strong shale.
Drivage Equipment	- BJD Heliminer 3.66 m wide, two passes. - 12 m bridge conveyor. - Girder setting brackets.
Coal Clearance	- 1.07 m belt conveyor. - Boltless structure. - FSW modular in seam 112 kW Drive with 100 m capacity loop belt reel and automatic belt tension.
Materials Transport	- Diesel & Battery locomotives & Pikrose flatbed materials cars.
Ventilation	- 90 kW Engart forcing fan with 760 mm lay flat ducting. - 37.5 kW Engart exhausting fan overlap at face, 13 m overlap. - Primary 6 m^3/s.
Manpower	- Heading crew 6 (includes bolting, belt, pipes, ventilation, cables & track extension).
Performance	- 150 m average per week (15 shifts). - Best shift 20 m. - Best week 170 m.

TABLE 4-4

133's SINGLE ENTRY RETREAT FACE - SHERWOOD MINE

Depth of Cover	600 m
Seam Height	3.4 m
Height Mined	3.1 m
Face Length	55 m
Panel Length	1240 m
Pillar Width	50 m
Gradient	1 in 25 along entry; 1 in 20 to blind end
Shearer	- BJD B59 DERDS (225 kW) - 1.68 m dia drums with pick face flushing - 0.68 m web - Powered cowls - Max cutting speed 9.8 m/min - Pitcraft haulage - Bretby cable handler
AFC	- NCB Heavy duty side discharge with Winster 90° Gearbox and 120 kW motor - Twin inboard 22 mm chain, 1 metre flight spacing - Pitcraft furnishings incorporating 0.26 m^2 ventilation duct
Stage Loader	- NCB Heavy duty 120 kW in line drive with twin outboard chains and half metre flight spacing - Coal sizer with standard AFC gearbox and 120 kW mounted on stage loader - Stage loader discharge fixed onto conveyor tail end (articulation only)
Face Supports	- Gullick 4 x 370 t chock shields with rigid canopies and face sprags. 1.5 m centres - Blind end chock fitted with anti flushing plate (attached to canopy) overlapping lower anti flushing plate (attached to return end of AFC) - Electronic control fitted but not operational awaiting computer card suited to Bi-Di operations - Outbye Hauhinco pumping station with HP supply 45 mm steel + screw fittings and LP return 64 mm victaulic pipe to face.

TABLE 4-4 (Cont'd)

133's SINGLE ENTRY RETREAT FACE - SHERWOOD MINE

Roadway Supports	- 150 mm x 127 mm x 3.1 m x 5.4 m flat top Hollybank arches (3 piece) at 1 m centres, meshed and strutted
Roadhead Supports	- 2 - Dowty 4 x 280 t Roadhead supports with extended powered forward cantilever to support crowns in face entry area. Spans 6 crowns.
Gate Conveyor	- FSW modular in-seam conveyor - 112 kW drive, 1.2 m wide - 96 m automatic loop take up - Return end located and held by 4 horizontal staker rams - Conveyor belt stored automatically as AFC/stage loader retreated
Ventilation	- Primary - 90 kW Engart forcing fan through 900 mm lay flat ducting connected through to blind end - Secondary - 2 x 37.5 kW Engart fans forcing air through 900 mm lay flat ducting to rear of ribside roadhead powered - support Primary - minimum 5 m^3/s, actual 6 m^3/s Secondary - minimum 3 m^3/s - Waste drainage through pipe left behind in abandoned drivage at 50 m intervals, old gate walled off at 20 m intervals CH_4 capture low - Monitoring - BA5 velocity (blind end) - Alarm 5 m^3/s - BM3 Blind End) - BM3 Chock #3) Alarm 0.8% CH_4 - BM3 Gate/Face) Cut off 1.25% CH_4 - Typical Return - 0.57% CH_4
Power	- 1100 v - Transformers outbye district - Gate end boxes and console, lighting and monitoring mounted onto stage loader

TABLE 4-4 (Cont'd)

133's SINGLE ENTRY RETREAT FACE - SHERWOOD MINE

Face Manpower/Shift	- Shearer	2
	- Chocks	1
	- Rams	1
	- Roadhead	1
	- Stage loader/console	1
	- Supervision	1
		7
	9 man Limit Mechanic and electrican on call	
Performance	- Best shift - 1100 t saleable - Best week - 8000 t sal. (15 sh.) - Face availability 5.5 hrs - Best advance/day 27 shears 18.4 m	
Installation	- 2 weeks - chock installation (36 + 2) - 3 days	
Salvage	- not yet attempted but 2 week transfer planned	

TABLE 4-5

206's SINGLE ENTRY RETREAT FACE - MANSFIELD MINE

Depth of Cover	665 m
Seam Height	2.3 m
Seam Height Mined	2.3 m
Face Length	45 m
Panel Length	960 m
Pillar Width	55 m
Gradient	1 in 20
Roadway Width	5.2 m
Shearer	- Anderson Strathclyde AM17 DERDS. (202 kW) - Pitcraft chainless haulage. - 0.65 web - 1.65 m dia. drum with pickface flushing and 9 port/RAC extraction - Pitcraft on-board water boost pumps to give 8 Mpa pressure - Cutting speed 5 m/min - Mansign cable handler - Shearer cutting on the wedge
AFC	- Twin inboard 22 mm chain - 150 kW Mining Supplies side discharge drive head - Two speed motor, right angled gearbox - Non-driven return end - Pitcraft furnishings including ventilation duct
Stage Loader	- Beam type - 112 kW in line drive with NCB spec motor and gearbox - Twin outboard 19 mm chain - Coal sizer - Stage loader fully boxed in
Face Supports	- Dowty 4 leg 325t chock shields (30) at 1.5 m centres - Bi-di adjacent control - Hydraulic forepoles fitted to chocks

TABLE 4-5 (Cont'd)

206's SINGLE ENTRY RETREAT FACE - MANSFIELD MINE

Roadway Support (Figure 4-27)	- Dowty 4 leg 325t chock shields (3), two roadside units kept in advance. - 5.2 m wide by 2.9 m high Donisthorpe type arches (radiused corners) at 1.2 m centres, strutted and lagged.
Gate Conveyor	- FSW 150 in seam conveyor - 112 kW drive - 1100 tph capacity - 50 m storage capacity in loop take-up - 1.07 m wide - Hydraulic clamp and powered belt reel station - Automatic tensioning using PIAB 3 controller - Full monitoring protection - Conveyor controlled by surface computer

Ventilation	- Twin fans with twin ducts in roadway
	- 90 kW fan through 900 mm steel ducting connected by flexible ducting to face duct, discharging into blind end
	- Minimum quantity 5.0 m^3/s average quantity 6.0 m^3/s
	- 37 kW fan, through 760 mm steel ducting discharging at rear of roadside powered support
	- Minimum quantity 3.0 m^3/s average quantity 4.0 m^3/s
	- Methane emission 10.55 litres/sec (average general body readings)
	- Monitors
	  - Flow in blind end of duct BA5 alarms at 5.0 m^3/s
	  - BM3's at blind end, at #3 chock and at roadhead, all set to trip at 1.2% CH_4
	  - BM3 at outbye end of roadway set to trip at 1.0% CH_4
	  - BM1 on intake side of 90 kW fan set to trip at 1.0% CH_4
	  - Smoke detectors in entry
	  - Vibration units on fans
	  - CO monitored by tube bundle to surface

TABLE 4-5 (Cont'd)

206's SINGLE ENTRY RETREAT FACE - MANSFIELD MINE

Power	- 1100 V - Transformers outbye district - Gate end boxes (twin contactor type) and console, lighting transformer and monitoring mounted on stage loader.
Face Manpower/Shift	- Shearer 2 - Supports/rams 1 - Stage loader 1 - Supervision 1 5 - 9 man limit - Electrician and mechanic on call
Materials Transport	- Gullick Dobson MP100 slimline FSV (diesel). 1.8 m wide. One operator in single entry
Performance	- Average Advance/week 62.6 m - Average tonnes/week-saleable 5460 t -ROM 8800 t - Best weekly sal. tonnes 8040 t - Average sal. tonnes/shift 427 t - Best sal. tonnes/shift 890 t - OMS - average (face) 84 t/MS - best (face) 128 t/MS
Maintenance	- Scheduled 12 hours/week - Non-Scheduled 22 hours/week (avg) - Shearer 5 - AFC 2 - Support 1.5 - Stage loader 5 - Gate c/v 8 - Other 0.5
Face Installation	- 42 shifts - 650 manshifts - 14 men/shift - FSV used
Face Salvage	- 42 shifts - 270 manshifts - 6 men/shift - FSV used - Last 4 cuts on face meshed and bolted

TABLE 4-5 (Cont'd)

206's SINGLE ENTRY RETREAT FACE - MANSFIELD MINE

Revenue & Operating Costs ($/t)	Face	Development
Revenue	104.19	104.19
Operating Cost		
- Labour	3.10	3.29
- Materials	0.67	3.96
- Power	0.35	0.35
- Other	5.73	4.30
- Total	9.85	21.90
No. of reuses of equipment	40.00 (10 yrs)	40.00 (10 yrs)

TABLE 4-6

SINGLE ENTRY FACE - PANEL #14 - STOLZENBACH MINE

Depth of Cover	160 m
Seam Height	3.5 - 5 m
Seam Height Mined	3.3 m
Face Length	50 m
Panel Length	500 m
Pillar Width	n/a
Gradient	Face on full dip to blind end.
Face Machine	- Eickhoff ESA 60L single drum shearer with 0.75 m arm. - 1.60 m diameter drum with phased pick face flushing. - 60 kW drive motor, water cooled by water/oil emulsion (98/2) of powered support system. - 0.625 m web. - Cutting speed (in soft lignite) 9 m/min. - Eicotrack chainless haulage.
AFC/Stage loader combined (curved C/V)	- Halbach & Braun EKF 2 single centre chaim (30 mm) curved conveyor. - 200 kW single motor drive. - Roller curve to reduce wear and friction. - Roller curve kept clear of fines by compressed air jets. - Automatic chain tensioning. - Gate road length 32 m. Total length of conveyor 82 m.
Face Supports	- Hemscheidt 2 leg G490 Shield supports at 1.5 m centres, one web back. - Sliding roof bar (full width). - Face sprags. - Multi-hose pilot control. - 2 Hauhinco EHP3 K70 pumps located in main district roadway (up to 800 m from face). - Blind end support has lateral anti-spall plates to control side and roof. - Special high thrust (300 kN) rams for advancing conveyor due to high frictional resistance. - Gap seals between supports at main and front canopies.

TABLE 4-6 (Cont'd)

SINGLE ENTRY FACE - PANEL #14 - STOLZENBACH MINE

Roadhead Supports	- Hemscheidt 2 leg shield supports (2) with 1.5 m long rigid canopy sufficient to support beams of roadway support when faceside leg removed. - Roadway trapezoidal with 3.4 m rigid roof beam, 3.0 m rigid ribside leg and 3.0 m curved yielding face side leg.	
Gate Conveyor	- 800 mm belt width, 2.5 m/s speed.	
Ventilation	- No data made available other than flexible duct used on face. Seam non-gassy.	
Power	- Control panels, switchgear and transformer in gate road on special monorail pantechnicon.	
Manpower/Shift	- Machine	1
	- Supports	2
	- Face/Roadhead	1
	- Stageloader	1
	- Supervision	1
	- Mechanic	1
	- Electrician	1
		8
Performance (2 shifts/day)	- Best shift - 1400 t - Best day - 1785 t - Best advance (shift) - 7 m - Best advance/day - 10.30 m - Best face OMS - 110 t/MS - Average Shift - 920 t - Average Advance (shift) - 4.5 m - Average OMS (incl. fitters) - 88t/MS	
Face Transfer (21 completed)	- Duration 12 to 14 days. - 400 to 500 manshifts. - Diesel powered monorail transport including chock transfer. - Includes drivage of salvage chamber. - Winches and sylvesters used to position chocks in new face.	

TABLE 4-7

#1 MINI-WALL SINGLE ENTRY FACE - GRETLEY MINE

Depth of Cover	75 m
Seam Height	1.8 - 2.5 m
Seam Height Mined	2.0 m
Face Length	36 m
Panel Length	2000 m
Pillar Width	25 m
Gradient	Flat
Shearer	- BJD Ace SERDS - 300 kW motor - 1.5 m diameter drum, pick face flushing (2.04 litre/sec). - 1.0 m web. - BJD multi-drive rack haulage. - 10 m/min cutting speed (max). - Machine only 5.08 m long incl. drum. - 3 shoe underframe to permit travel into gate over roller curve. - Radio control available.
AFC/Stageloader	- Halbach & Braun EKF2 single centre chain (30 mm) curved conveyor. - 160 kW drive motor. - Closed bottom pans. - Klockner SB63M 112 kW coal sizer mounted on 'stage loader' section. - Telescopic pan with hydraulic cylinders in gate section. - Gate length 20 m. Fixed discharge overlap. - Total length 60 m.
Face Supports	- Dowty 2 leg shields 400 t capacity. - Set at 2 m centres. - Supports equipped with ventilation leakage seals. - Electro-Hydraulic control with a reprogrammable main gate computer. - 4 m length in collapsed position (for transport). - Height range 1.4 - 2.8 m. - Hauhinco EHP 3K 125/50 pump. - Readily transported by LHD with fork lift attachment. - One web back operation. - Hydraulic articulated front cantilever. - Heavy duty rams.

TABLE 4-7 (Cont'd)

#1 MINI-WALL SINGLE ENTRY FACE - GRETLEY MINE

Roadway Supports	- Roadhead powered supports (2) identical to face supports. - Roadway supported by W straps and 4 rock bolts at 0.9 m and 1.5 m centres.
Gate Conveyor	- Fox 225 kW in seam drive. - 168 m loop storage capacity with automatic tension and take up. - Belt reel station with 170 m capacity and integral hydraulic clamps (30 min. cycle). - 1.05 m wide belt. - Slow speed capability for handling supplies from face. - 800 tph capacity. - 6 m long tail end capable of vertical and horizontal realignment after pushover.
Pantechnicon	- 4 sledges - Communication and control. - Hydraulic pump and tank. - Transformer. - Puller sled (advances pantechnicon off monorail). - Monorail carries up to 300 m of 11kV flexible electric cable and water hose.
Ventilation (Figure 4-30)	- Through roadway ventilation diverted through face by seals on shields. - Fast end side 2.0 m from edge of last support (Figure 4-34) to allow air to return across waste.
Materials Transport	- General supplies - FSV - Longwall equipment - LHD with fork lift attachment.
Manpower/Shift	- Shearer 2 - Supports 1 - Roadhead 1 - Supervision 1 - Mechanic 1 - Electrician 1 7

TABLE 4-7 (Cont'd)

#1 MINI-WALL SINGLE ENTRY FACE - GRETLEY MINE

Performance	- Face due to start February 1988. - Expected rate of retreat 40 m - 60 m/day.
Face Transfer	- 3 Days (over approx. 100 m) is targetted.

TABLE 4-8

E08'S SINGLE ENTRY FACE - SOUTH KIRKBY MINE

Depth of Cover	415 m
Seam Height	1.60 m
Height Mined	1.60 m
Face Length	35 m
Panel Length	600 m
Pillar Width	35 m
Gradient	1 in 34 on roadway, face level.
Shearer	- Anderson Strathclyde SERDS. - 150 kW, 1100 v. - 1.37 m diameter drum, 0.68 m web. - Pickface flushing. - Rackatrack chainless haulage.
AFC	- NCB 48 kW spec drive and gearbox. - Twin outboard 19 mm chain. - Closed bottom pans. - Bretby cable handler. - Ventilation duct on spill plate.
Face Supports	- Gullick Dobson 5 leg 200 t shields. - 1.2 m forward cantilever bars.
Stage loader	- Fixed beam conveyor. - 48 kW drive
Gate Conveyor	- Huwood 914 mm belt conveyor with powered loop take up.
Roadhead Supports	- 8 leg Gullick Dobson anchor chock at ribside, and 2 9 leg Gullick Dobson supports with SMRE extended canopies.
Roadway Supports	- 4.88 m Hollybank beams pin jointed to 1.98 m splayed legs. Sets at 0.91 m centres. - Additional wood props set in centre, replaced by hydraulic props near face.
Ventilation	- 90 kW exhausting primary fan with 900 mm ducting. Fan located outbye entrance to gate road. - Primary fan flow 6.5 m^3/s. - 11 kW secondary forcing fan on stage loader forcing air through 500 mm x 200 mm duct to blind end. - Secondary fan flow 2.0 m^3/s. - Monitoring through Index velocity switch, BM1 and BA4 methane detectors and tube bundle. - Seam not gassy.

TABLE 4-8 (Cont'd)

E08'S SINGLE ENTRY FACE - SOUTH KIRKBY MINE

Manpower	- Shearer	2
	- Supports	2
	- Stageloader	1
	- Supervision	1
		6

9 man limit
Mechanic and Electrician on call.

Performance (3 shifts) Face	E07	E08	E09
Tonnes produced (t)	44758	32155	20750
Weekly output (t)	960	1235	1380
Advance 1 day (m)	2.56	4.63	4.06
Average OMS (district)	11.8	16.3	15.2
Best OMS (district)	31.9	78.6	n/a

Operating Cost (1981)

Labour	18.8
Materials	10.5
Power	1.8
Equipment Rentals	2.5
Other	3.1
	$36.7

TABLE 4-9

WOODFIELD 37'S SINGLE ENTRY FACE - MEASHAM MINE

Depth of Cover	130 m
Seam Height	1.50 m
Height Mined	1.50 m
Face Length	50 m
Panel Length	270 m
Pillar Width	not applicable
Gradient	1 in 9 along face, roadway level.
Shearer	- Anderson Strathclyde AS16 SERDS - 149 kW motor, 550V. - 1.15 m diameter drum. - 0.61 m web. - Rackatrack chainless haulage. - Dowty Meco headframe - NBC Spec Gearbox. - 67kW 550V motor. - Twin outboard 19 mm chain. - Perard cable handler. - Closed bottom pans.
Powered Supports	- Dowty 4 leg 203 t shields. - Extended front cantilever. - Gullick T30 pump sited outbye.
Stage loader	- NCB Spec Drive and Gearbox. - 49 kW 550V motor - Twin outboard 19 mm chain. - Covered bottom pans. - Piggyback system with 10 m overlap. - Switchgear and forcing fan carried on stage loader.
Roadhead Supports	- Dowty '4 in line' junction support. - 4 leg 203 t rating. - Triple roof beams 6.7 m long.
Roadway Support	- 3.44 m x 2.44 m 3 piece arches lagged with steel sheets.
Power	- Transformer (500kVA) located outbye district in intake air. - Stoppage of primary fan trips transformer.
Ventilation	- Exhausting/forcing overlap system. - Primary exhausting fan 37 kW with 610 mm diameter steel ducting with final length of flexiduct delivering to rear of roadhead chocks. - Primary fan flow (min) 3.0 m^3/s.

TABLE 4-9

WOODFIELD 37'S SINGLE ENTRY FACE - MEASHAM MINE

Ventilation	- Secondary forcing fan 19 kW with silencer mounted on stage loader then through 500 mm diameter flexiduct to blind end.
	- Secondary fan flow (min) 2.0 m^3/s.
	- Monitoring (Figure 4-40)
	  - Air velocity at blind end.
	  - BM1 methanometer at roadhead.
	- Seam not gassy

Manpower (1 shift)	- Shearer 1 - Supports 3 - Roadhead 2 - Supervision 1 - Mechanic 1 - Electrician 1 9 Note: Deputy + 2 men advanced stable on second shift.
Performance (1 shift working on face)	weekly saleable output - Avg 730 t - Best 1100 t Face OMS - Average - 16.4 t/MS - Best - 24.5 t/MS

TABLE 4-10

K49R SINGLE ENTRY FACE - PYE HILL MINE

Depth of Cover	
Seam Height	1.85 m
Height Mined	1.53 m
Face Length	14 m
Panel Length	240 m
Pillar Width	not applicable
Gradient	1 in 30 on face to gate
Face Machine	- DOSCO In-Seam Miner ISM1530. - 2 x 45 kW motors. - Cutting height 1.5 - 1.6 m. - Machine length 15 m - 22 kW Hydraulic power pack for 15 m on stage loader. - Cutting rate 100 tph.
Face Conveyor	- ISM flights remove coal from face, direct discharge onto the belt conveyor.
Face Supports	- Dowty 6 leg 240 t chocks (11). - 37 kW power pack situated outbye at the cross junction. - Powered supports advanced by batch control from console in gate when no men on face. - ISM advanced by two outrigger Jacks supplemented by 4 rams on the supports. - 2 face supports at roadside fitted with anti-tilt rams to counter any broken floor next to dint.
Gate Conveyor	- FSW Lion belt conveyor. - 910 mm belt width. - Powered loop take up with automatic control. - ISM delivers direct onto rigid tailend box, 1.1 m wide, located in the dint.
Roadhead Support	- 2 Dowty sliding chocks, face side chock attached to belt conveyor return end. - 1 sliding beam Desford (4 in line) chock in centre of roadway outbye face.
Ventilation (Figure 4-43)	- Primary fan, 37 kW exhausting through 760 mm ducting with provision for automatic changeover in the event of power failure to naturally induced ventilation through pit pressure. - Secondary forcing fan 4 kW through 460 mm ducting from fan adjacent to face to blind end.

TABLE 4-10 (Cont'd)

K49R SINGLE ENTRY FACE - PYE HILL MINE

	- Primary fan flow 5 m^3/s.
	- Secondary fan flow 3 m^3/s.
	- Monitoring.
	  - Air velocity at face duct exit.
	  - Methane (BM1) at roadhead.
	- A standby 19 kW forcing fan located in return roadway with degassing chamber to undertake any degassing operations.	

Manpower/shift (1 shift/day)	- ISM	2
	- Supports	1
	- Face Transfer	1
	- Gate Belt	1
	- Electrician	1
	- Mechanician	1
	- Supervision	1
		8
	12 man limit.	
Performance (1 shift)	- Advance per day	- Best 10 m - Avg 6.8 m

Operation Costs (including development) (1983)

	$/t
Labour	73.6
Materials	18.4
	92.0

Installation (2 shifts/day)	- Chocks	2 weeks
	- In-Seam Miner	3 weeks
	- Gate Belt etc.	2 weeks
		7 weeks

TABLE 4-11

SE1 SINGLE ENTRY FACE - CADLEY HILL MINE

Depth of Cover	n/a
Seam Height	2.25 m
Height Mined	1.98 m
Face Length	45 m
Panel Length	400 m
Pillar Width	25 m
Gradient	
Shearer	- BJD Maximatic DERDS. - Roll Rack chainless haulage. - 1.37 diameter cutter head. - 0.75 web. - Pick face flushing.
AFC/Stage loader	- Dowty Meco short roll curve AFC. - Single centre 26 mm chain. - 90° roller curve. - 112 kW in-line motor and gearbox. - Closed bottom pans. - Furnishings include 800 mm x 250 mm ventilation duct. - 350 tph capacity. - 45 m face length, 22.5 m gate length, total 67.5 m.
Face Supports	- Dowty 4 leg 280 t compact chock shield supports (37). - Powered cantilever (1.5 m) and side flaps. - Hydraulics used new synthetic fluid. - Electro Hydraulic controls. - Dowty 4 leg 280 t chock shield plus 2 leg 60 t extension, and a Dowty 4 leg 280 t chock shield plus 1 leg 30 t extension. - Both supports used extended beams.
Roadhead Support	- 3.96 m x 2.13 m flat top arches set at 0.91 m centres. - Top and ribside lagged with weldmesh. - Face side wooden lagged.
Ventilation (Figure 4-45)	- Exhausting/Forcing overlap systems. - Primary exhausting fan 37 kW using 610 mm steel ducting. - Primary fan flow 6.5 m^3/s.

TABLE 4-11 (Cont'd)

SE1 SINGLE ENTRY FACE - CADLEY HILL MINE

	- Secondary forcing fan on 'stage loader' 37 kW delivering 2.0 m^3/s to the blind end.
	- 37 kW standby degassing fan installed with isolating and change over switch.
	- Monitoring
	  - Duct velocity alarms in exhausting duct and at blind end. Face alarms at 1.5 m^3/s and cuts off all power except fans, exhausting duct at 5 m^3/s and cuts off power to shearer.
	  - BM1 methanometer at roadhead. Alarms at 1.0% and cuts off all power except fans.

Manpower/shift (2 shifts)	- Shearer 2 - Supports 3 - Stage Loader 1 - Electrician 1 - Mechanician 1 - Supervision 1 9 Note. 3 man crew on night shift on conveyor move up and preparation.
Expected Performance	Advance/day 6 m Output/day (sal.) 1200 t District OMS 57.1 t

TABLE 4-12

99A SINGLE ENTRY FACE - BEVERCOTES MINE

Depth of Cover	n/a
Seam Height	1.50 m
Height Mined	1.50 m
Face Length	60 m
Panel Length	600 m
Pillar Width	not applicable
Gradient	level
Shearer	- Anderson Strathclyde AM17 DERDS. - 1.52 m diameter drum with pick face flushing. - 0.68 web. - Extended FIDD arms. - Chain haulage.
AFC	- NCB spec drive (112 kW) and gearbox (150 kW). - Twin outboard 19 mm chain. - Ventilation duct in AFC furnishings.
Stage Loader	- 112 kW in line drive. - Fitted with jazz pans to divert to gate belt.
Face Supports	- Gullick Dobson 6 leg 240 t chock. - Modified front beam (0.55 m) to meet prop free front requirements.
Roadhead Supports	- 3.6 m x 2.8 m Hollybank flat top arches.

Ventilation (Figure 4-50)	- Two primary forcing fans each with own duct.
	- 90 kW forcing fan delivering min. 7 m^3/s through 900 mm steel ducting, torpedo unit and face ducting to blind end.
	- 37 kW forcing fan delivering 4.5 m^3/s (min) through 760 mm steel and layflat ducting to rear of roadhead supports.
	- Monitoring
	  - 90 kW fan circuit
	  - BA5 airflow at blind end.
	  - BM3 methanometers at fastend, mid face and roadhead.
	  - Both fans have FIFFI vibration monitors.
	  - FIDESCO CO and POC monitor outbye fans.
	  - AFD carried on each shift (2 min) set between BM3's on face.

TABLE 4-12 (Cont'd)

99A SINGLE ENTRY FACE - BEVERCOTES MINE

- Methane drainage set up using pre drilled holes. Little CH_4 capture resulted.
- Methane emission rates between 130 and 200 litres/sec gives minimum total air requirement of 11.5 m^3/s.

TABLE 4-13

PROPOSED SINGLE ENTRY FACE - RHEINLAND MINE

Depth of Cover	730 m
Seam Height	1.95 m
Height Mined	1.95 m
Face Length	33 m
Panel Length	600 m
Pillar Width	not applicable
Gradient	along face 3°
	along roadway 3°
Face Machine	- Eickhoff ESA 150 single drum machine. - 150 kW water cooled motor 1000 V. - Eicotrack haulage. - 0.75 m web. - 1.05 m ranging arm. - Pick face flushing.
AFC	- Eickhoff EKF 2 chain conveyor. - Single centre (22 mm) chain.
Face Supports	- Kloeckner - Becorit 2 leg shields with integral ventilating and escape duct. - 1.5 m centres. - Extensive forward cantilevers, power set.
Roadhead Supports	- Rockbolts. - Sliding Bars and Hydraulic Props. - No powered supports. - Monolithic pack 0.7 m wide.

Ventilation	- Forcing fan in through ventilated roadway situated on inbye side of face.
	- Dual Power- 24 kW electric.
	- 4 compressed air nozzles.
	- Mainstream flow 1.3 x fan flow.
	- Fan flow $10m^3/s$.
	- 900 mm steel ducting leading to 0.6 m^2 ventilation box on face.
	- Fan and ducting supported on monorail.
	- Seam non gassy.
	- Minimum air speed 0.5 m/s.
	- Monitoring
	  - Airflow in main roadway, on face and in face ventilation duct.
	  - Methane at roadhead, on face and at blind end.
	  - All monitoring to central computer control station.
	  - Warning at 0.1% CH_4.
	  - Non-intrinsically safe equipment cut off at 0.3% CH_4.

TABLE 4-13 (Cont'd)

PROPOSED SINGLE ENTRY FACE - RHEINLAND MINE

Expected Performance	- Advance/shift	5.0 m
	- Saleable tonnage/shift	350 t
	- ROM tonnage/shift	700 t
	- Manpower	12

TABLE 4-14

DOSCO IN-SEAM MINER - CUTTING RANGES

Seam	Height (m)	Cutting Centres (m)	Width (m)
Thin	0.86 - 1.05	4.25	5.11 - 5.30
Medium	1.07 - 1.22 1.27 - 1.42	4.25 - 13.37	5.32 - 14.59 5.52 - 14.79
Thick	1.37 - 1.52 1.58 - 1.73	2.73 - 13.37	4.10 - 14.89 4.31 - 15.10
ISM 3000 (dble jib)	2.50 - 3.15	3.8	6.30 - 6.95

TABLE 4-15

DEEP HARD/PIPER PARTIAL EXTRACTION DRIVAGE - SHERWOOD MINE

Depth of Cover	600 m
Seam Height	3.1 m
Heading Width	7.35 m
Heading Length	continuous
Gradient	1 in 25
Pillar Width	7.3 m
Partial Extraction	approximately 50%
Roadway Support	- 150m x 127 mm RSJ with radiused ends to fit cut cusp, Hollybank type with pinjointed legs at each end of middle set by girder clip. - Strutted and lagged (mesh) - 1.3 m centres - Rock bolts 2.3 m long, full column resin 24 mm rebar intended to be set (7 No.) between supports - Drilling equipment not capable of completing cycle within machine cycle. Being improved - Ultimate target is to dispense with arches
Drivage Machine	- Dosco In Seam Miner 3000. (Twin jib stacked machine) (180 kW cutting power) complete with 3 hydraulic roof drills, staker rams, and girder setting device and Dowty roof canopy behind jib
Coal Clearance	- 22 m long machine conveyor (chain) onto 1.37 m wide belt conveyor - FSW modular in-seam conveyor with belt reel station, automatic loop take up (96 m) - 90 kW drive - Tail end positioned and spragged by four horizontal hydraulic rams
Materials Handling	- GMT Bo-Bo Battery locomotive and GMT flat materials cars to back of machine. Manhandled from there.
Ventilation	- Primary - 2 x 37.5 kW Engart fans in series forcing air through fibreglass ducting (0.91 m) to rear of machine

TABLE 4-15 (Cont'd)

DEEP HARD/PIPER PARTIAL EXTRACTION DRIVAGE - SHERWOOD MINE

	- Secondary - 1 x 37.5 kW Engart fan exhausting air from ducts on cutting head; discharging through Joy microdyne wet dust filter. 50 m ducting length. - Primary 6 m^3/s - Secondary 3 m^3/s - BM1 Methane Unit on machine
Manpower	- Machine 3 Materials 3 Supervision 1 7* = * includes extension of pipes, track, ventilation and conveyor - 15 man limit
Performance	- Best shift 16 m - Best week 120 m (15 shifts) - ISM cutting rate 4.6 m/hr - Drove 22 m radius curve (inside) through 48° and 22 m straight drivage on 6.4 m wide girders in 3 weeks - Potential drivage rate on rock bolts only is 200 m/week

TABLE 4-16

COMPARISON OF ESA 150 AND VME MACHINES IN SINGLE ENTRY SHORT RETREATING SYSTEMS

	EICKHOFF ESA 150	WESTFALIA VME
Machine Length (m)	3.20	1.70
Machine Height (m)	1.55	1.0/1.5
Machine Width (m)	2.05	2.80
Cutting Range - Height (m)	1.8-3.5	1.2-3.2
- Length (m)	4.6-50.0	4.5-50.0
Cutter Drum diameter (m)	1.60	0.9-1.20
Cutter Drum width (m)	0.75	---
Cutter Drum rpm	32/39	75/90
Cutting Power (kW)		120
Anciliary Power (kW)	150	63
Total Power (kW)	150	183
Haulage	Eicotrack chainless	chain
Haulage speed (m/min)	5.6	20.0
Machine weight (t)	16	5

TABLE 4-17

COMPARISON OF SINGLE ENTRY SHORT LONGWALL FACES

	SHEARER	ESA/VME
Face Length	Same	Same
Face Height	5.0 m max.	3.5 m max.
Power	150-375 kW	60-183 kW
AFC Pan/chain	Standard	Standard
AFC Furnishings (incl. vent. duct)	Standard	Standard(ESA) Special(VME)
Chainless Haulage	Standard	Standard(ESA) Chain (VME)
Powered Supports	Standard	Standard
Stage Loader	Standard	Standard
Curved Conveyor (Alternative)	Standard	Standard
Roadhead Supports	Standard	Standard
Ventilation System	Same	Same
Monitoring System	Same	Same
Production Capacity (Best)	26,928 t	14,255 t
Capital Cost	$0.9 m	$0.7 m
Operating Cost	Same	Same

PART 5

SITE SPECIFIC DESIGN GUIDELINES

PART 5 - SITE SPECIFIC DESIGN GUIDELINES

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PART 5 - SITE SPECIFIC DESIGN GUIDELINES

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5.1 INTRODUCTION

In this section of the report, guidelines are given for the design, layout, equipping and operation of single entry faces in the selected reserve area at the Prince Mine.

The guidelines present specifications for the equipment which it is felt will provide the safest and most efficient system, however it is realized that the initial faces used to prove the system will probably be based to a greater extent on equipment currently available to and within CBDC mines.

Comments are included on the effects the use of existing equipment may have on performance and safety.

The final design, layout and equipping of a single entry face will require a more detailed evaluation involving a greater involvement of the staff and engineers of CBDC HQ and the Prince Mine than is possible or required by this study.

The critical aspects of a single entry system for the Prince Mine are discussed in the following sections. These include:

- Selected Mining Area
- Basic Layout
- Support
- Development Equipment
- Production Equipment
- Ventilation
- Manpower
- Production and Productivity
- Face Installation, Salvage & Transfer
- Regulatory Aspects, and
- Costs.

In setting out these guidelines, it should be noted that there are many permutations of equipment and methods possible. This report deals only with the major applications.

5.2 SELECTED MINING AREA - PRINCE MINE

In the discussion presented in Section 3.6, it was indicated that firstly, only the Prince Mine was considered initially suitable for possible application of the single entry system (methane emissions being too high at Lingan and Phalen Mines) and secondly, that the area between the longwall workings and the shoreline, west of the main deeps contained the best conditions of the available areas. Within this designated area, a block 1000 m x 1600 m was selected for the initial mining (Figure 5-1).

In selecting this area, it has been assumed that the initial mining area should be as close to the existing mine access and services as was practical.

5.3 BASIC LAYOUT

5.3.1 General

Before evaluating single entry face geometry and gate road support requirements, it is important to characterize the ground in which mining will take place. This entails an assessment of the local geology, the quality of the rock mass, the intact rock strength and the prevailing stress regime. The majority of this work has been carried out previously and the results were available from CBDC.

5.3.2 Geology

CBDC have prepared a number of plans and cross-sections from the results of underground mapping and from exploratory boreholes that can be used to predict geologic conditions in the proposed single entry mining area.

Typically the coal seam is of the order of 2.3 m thickness and is overlain by between 60 m and 95 m of mudstones, siltstones and sandstones. Seatearths are present immediately beneath the coal and in places may be up to 100 mm thick, though from available data would appear to average 50 mm.

The immediately coal roof is expected to be mudstone and siltstone with a thin rider seam some 200 - 600 mm above the top of the coal. Sandstone units of any significance would appear to be remote from the immediate roof area. Geologic interpretation provided by CBDC staff also indicate that the proposed single entry area is devoid of major sedimentary or structural anomalies.

5.3.3 In Situ Stress

A number of in situ stress measurements have been carried out in the Sydney Coalfield. The results obtained indicate that the vertical stress is approximately equivalent to the overburden load (that is the depth of the point of interest times the unit weight of rock), while the average horizontal to vertical stress ratio approaches unity at depths of cover greater than about 600 m. At shallower depths this ratio increases with values approaching two at depths of cover of some 100 to 200 m.

The orientation of the three principal stresses are reasonably consistent throughout the coalfield. At Prince Mine the major principal stress (σ_1) would appear to the sub-horizontal and parallel to the strike of the coal seam; the intermediate principal stress (σ_2) would appear to be also sub-horizontal, orientated perpendicular to strike; while the minor principal stress (σ_3) would appear to be near vertical.

5.3.4 Material Properties

The results of uniaxial compressive strength testing of the major lithologies at the Prince and Lingan Mines are given in Table 5-1.

The values in Table 5-1 represent the strength of intact samples of rock, as determined in the laboratory. Due to the various discontinuities, such as bedding and jointing, that are inherent within the rock mass, these values have to be reduced in order to obtain an estimate of the in situ rock mass strength. Experience indicates that for well jointed mudstones and siltstones, typically found in the coal roof at Prince, the in situ uniaxial rock mass strength is about one third to one quarter the laboratory value. Though a number of more complex formulations exist for estimating rock mass strength (e.g. Hoek and Brown, 1981) the above simple approximation is believed adequate for this present conceptual stage of mine layout.

The uniaxial compressive strength represents the strength of the rock mass in an unconfined state. With confinement, the strength of the rock mass will increase. Again a number of formulations exist (see Brown and Brady, 1985) and again for the present level of investigation a relatively simple relationship proposed by Wilson (1983) has been used:

$$\sigma_1 = \sigma_0 + k \times \sigma_3,$$

where

σ_1 is the major principal stress at failure,
σ_3 is the confining stress
σ_0 is the uniaxial compressive strength of the rock mass, and
k is the stress factor, which for typical coal sequence rocks is between 3 and 4 (Wilson, 1983).

The intensity of jointing and bedding inherent within both the coal and immediate roof rock, the condition of their surfaces, and the number of discontinuities all impact the "quality" of the rock mass. In turn the quality strongly influences strata behaviour and support requirements. Though this interaction, between quality and behaviour, is complex a number of workers (Barton, 1974, Bieniawski, 1984 and Unal 1983) have defined measures of the quality which are then related to support requirements. These

measures can be obtained by a number of measurements and observations underground.

For the purposes of the present study, the system proposed by Unal (1983) has been used. A brief description of this system is given in Appendix A. Observations made during the underground visit to Prince indicate that according to Unal's system the immediate roof rocks could be given a quality number of 45, while the coal could be given a number of 35. It is emphasized that these are very preliminary estimates based on limited data.

5.3.5 Strain Criteria

The area at Prince Mine selected to investigate the feasibility of single entry mining lies between 55 m (180 ft) and 140 m (450 ft) below seabed. Given this proximity to such a large body of water the main design criterion will be to restrict mining induced changes in the permeability of the solid bedrock cover to within safe and acceptable values. Therefore "surface" subsidence control has an over-riding influence on the design and dimensioning of the workings.

Changes to the permeability of the overlying strata are a function of the stresses and strains induced by mining. In turn, these stresses and strains are determined by the depth of working, the physical and mechanical properties of the intervening strata, the height of working (i.e. mining height) and mine geometry. Obviously it is where permeabilities are increased, due to the "opening up" of the rock mass by tensile stresses and strains, that gives the most concern. Thus the principal criterion for determining the layout and geometry of single entry panels at the Prince Mine will be the maximum allowable tensile strain at surface; that is, at the seabed.

For the Sydney coalfield the maximum tensile strains at the seabed that will be allowed has been set at 8.5 mm/m. In addition both federal and provincial mining regulations,require a minimum depth of cover above any extraction area of 55 m (180 ft).

Though the mining induced strains are regarded as the principal geotechnical control on layout, a number of other factors have to be considered. These include the strength of interpanel (rib) pillars and the size of barrier pillars required to provide protection to the main entry system. A staged approach to assessing single entry layouts has therefore been adopted. Initially, values for surface strains were predicted for a range of panel geometries and depths. Once the strain criterion was satisfied and an acceptable geometry selected, the stability of interpanel pillars and the possible effects of stress transfer were examined.

5.3.6 Strain Profiles

Surface strains have been estimated with the aid of the empirically derived relationships proposed by the National Coal Board (NCB). These relationships, developed from a large number of case histories in the United Kingdom, allow complete subsidence and strain profiles to be predicted for a given mine geometry. As originally proposed (NCB, 1975), the requisite profiles were constructed from a series of charts and nomograms. Recently, however, a computerized version has been developed by Aston (1985), specifically directed toward subsidence studies for the Sydney coalfield. It is this version that has been used to determine preliminary layouts for single entry panels at Prince.

Initially complete strain profiles resulting from the mining of single panels were constructed. Panel widths were varied from 30 to 50 m, pillar widths from 15 to 40 m, and depths of working between 50 m and 100 m. Seam thickness was assumed constant at 2.3 m. The results obtained are given in Appendix A and summarized in Figure 5-2. This figure indicates that, in order to satisfy the tensile strain criterion, single entry mining should be restricted to areas where the depth of cover is 60 m thick or greater.

Panels will, however, not be mined in isolation. Adjacent panels may interact with each other, resulting in superimposition of strain profiles. The amount of superimposition will depend on the size of the rib pillars left between panels; the closer the panels being to each other the greater the interaction and the amount of induced strain at surface.

The strain profile associated with two panels and the intervening pillar can be obtained by simple superimposition of the predicted strain profiles for the individual panels. Thus the appropriate size for interpanel pillars can be estimated by adjusting the distance between the panels until the maximum allowable tensile strain is reached.

Plots of the tensile strains predicted to occur above different panel-pillar systems have been constructed. These are given in Figures 5-3 to 5-6 for a 30 m wide panel-pillar system at depths of cover of 50 m, 60 m, 75 m, and 100 m respectively, while Figure 5-7 shows the predicted profiles above a 30 m panel-15 m pillar system at 75 m depth and, Figures 5-5 and 5-6, the profile above a 35 m panel-30 m pillar system, also at 75 m and 100 m depth of cover. Figure 5-8 shows the predicted profile for a 35 m panel, 40 m pillar at 85 m depth. These figures illustrate two important points, namely the sensitivity of predicted tensile strain to panel width (compare Figures 5-5 and 5-8) and to depth (compare Figure 5-3 with Figure 5-6).

The results given in Figures 5-3 to 5-8 indicate that, for the depths of cover under review, the face length of single entry panels should not exceed 30 m until depths exceed 100 m, in order to keep tensile strains within allowable limits. Thus, for a 5 m wide roadway, the maximum face length is limited to 25 metres. Also at depths of cover of between 60 and 75 m, rib pillars should be at least 30 m wide. At depths greater than 75 m, however, the predicted magnitude of surface strains are such that these pillars can be reduced to 15 m width as long as pillar strengths can be shown to be adequate.

5.3.7 Pillar Stress

The above section has examined the panel and pillar geometries that allow the surface strain crtierion to be satisfied. It is, however, also necessary to:

- ensure that the rib pillars have sufficient strength to bear the imposed loads; and,
- ensure that the stress redistribution that occurs as a result of panel extraction does not jeopardize adjacent development roads and extraction areas.

The distribution of stresses in and around a total extraction panel has been investigated by a number of researchers and several sophisticated and numerically complex solutions are available. Such levels of sophistication are not warranted for the current level of study. Therefore, a relatively simple formulation has been used, relating the induced stresses in the abutment to the depth of working, the rock mass strength, the seam height and the width of extraction. This relationship was developed by Wilson (1983) and allows estimates to be made of the peak stress the immediate abutment area is able to withstand; the size of the yield zone between the ribside and the peak stress point; and, the decay of stress into the solid abutment from the peak value. The form of the stress distribution in the abutment area assumed is shown in Figure 5-9, while the various equations required to estimate the necessary values are given in Appendix A2.

Similar to the generation of strain profiles, it was assumed that abutment stresses arising from mining of adjacent panels could be superimposed. Figures 5-10 to 5-12 show the predicted stress distributions in the rib pillars for a 30 m pillar between two 30 m single entry panels at depths of 50 m, 75 m, and 100 m respectively, while Figure 5-13 shows the distribution for a 15 m pillar at a depth of 100 m. For comparison, the predicted stress profile in the rib pillar between the 1W and 2W longwall panels is shown in Figure 5-14. Salient aspects of the different stress profiles are

summarized in Table 5-2. Input parameters are summarized in Appendix A2.

The results contained in Figures 5-10 to 5-12 indicate that only in the vicinity of the immediate ribside are peak stress conditions predicted. In the central core of the pillars, stress levels are not greatly above premining values. Pillar stability is therefore not in question. Only when the pillar width is reduced to 15 m do the two stress peaks created by the adjacent panels begin to coalesce. Even then, a substantially confined core still exists. Therefore it is believed that the panel pillar geometry proposed in section 5.3.2 meets both the strain and stress/strength criteria.

5.3.8 Panel Layout

A number of geologic factors are important when considering panel layouts. These are:

- the depth of cover above the coal;
- the dip of the seam;
- the presence or otherwise of seatearths;
- the roof type.

Available geologic data for the proposed single entry mining area in Prince indicates that though the coal and overlying strata generally dip to the south, the depth of cover increases in a south westerly direction. As discussed above the selection of panel and pillar widths is sensitive to the depth of cover. The effect of this can be illustrated by considering two layout options.

In the first layout, the panels are oriented approximately at right angles to the main entries, as shown in Figure 5-15. These panels cross the depth of cover contours. Because panel geometry is controlled by the strain criterion, which in turn is a function of the depth of working, the panel and pillar widths will be determined by the minimum depth of cover that exists along the length of the panel. Referring to Figure 5-15, for panels laid out at right angles to the main deeps, the panel and pillar sizes will be controlled by the 60 m cover line. That is, to ensure that surface strains are within allowable limits, a 30 m panel and a 30 m pillar system should be adopted. This would result in a 50 per cent extraction ratio.

If, as an alternative, panels are laid out approximately parallel to the strike of the overburden isopachs, advantage can be taken of the increasing depth of cover. Such an orientation would allow the width of the inter panel (rib) pillars to be gradually reduced with increasing depth. In turn, this would result in a higher extraction ratio than the option described above. For example, if the initial panel was positioned below the 60 m cover line (approximately

1200 m west of the main entries) the inter panel pillar width should be 30 m. At a depth of cover of 100 m (approximately 600 m west of the main entries) the inter panel pillar width could be reduced to 15 m.

Irrespective of whichever option is adopted (or variation between the two options) a barrier pillar will have to be left between the various single entry panels and the main entries. Based on the estimated pillar stresses it is believed that a 60 m barrier pillar will be more than adequate for protection of the main entries.

The seam dips to the north at an angle to the overburden isopachs (Figure 5-15). From insitu stress measurements the major principal stress would appear to lie within the plane of the seam, paralleling strike. These stresses would tend to give rise to a clamping effect on the strata above the single entry panels inhibiting caving. Though in itself this mechanism is not considered important with respect to the control of surface strains, it may have an impact on the initial startup operations by delaying the onset of the first cave which in turn may result in increased loadings at the face. If, on subsequent analysis, this effect is considered important it could be minimized by altering the panel orientation.

Geologic plans indicate that, in the proposed single entry area of the Prince Mine, up to 100 mm of seatearth may be present beneath the coal floor. Though these seatearths may result in poor face conditions their presence is not expected to effect the sizing of either panels or pillars nor the orientation of the panel pillar system. The geologic plans also indicate that shale rocks will form the dominant roof type in the initial mining area. Again this is expected to have little influence on panel geometry.

In determining the direction of mining, another important factor to be taken into account, is the direction of the seam gradient and the desirability, for assisting with methane control of working the face retreating to the dip. This has the effect of helping to retain the methane in the waste area. The panels have therefore been established to retreat in the general direction E15°S which also coincides with the direction of the current mining panels. Whilst, because of variations in the seam contours, this results in varying gradients along the roadways (ranging from 1.5° in the southern end to 0.5° in the northern end of the area) it ensures that all faces retreat to the dip. This also enables all faces to be worked in parallel to each other, and is also in the same general direction as the current west side faces (Figure 5-16).

Pillar widths are dictated by the minimum depth of cover present in each panel. Examination of Figures 5-2 and 5-16 suggest three zones where different panel/pillar widths combinations for different depths of solid cover are possible without exceeding the 8.5 mm/m

strain criteria. Taking all these various factors into account, the panel, face and pillar widths proposed for the initial single entry mining area are given below. It should be noted that the face length is the panel width less the roadway width (5 m).

Depth of Solid Cover (m)	Panel Width (m)	Face Length (m)	Pillar Width (m)
60 - 75	30	25	30
75 - 100	30	25	20
+100	35	30	30

The overall extraction ratio in the panel is 56% representing some 2.75 Mt of coal from 28 single entry faces.

In assessing which direction the face should be off the roadway, to the rise or dip, several factors were taken into account. These include:

- ventilation and methane control,
- ease of face development,
- direction of coal transportation,
- potential support and stability problems at face/roadway interface.

Methane control is by far the most important, so faces should also be kept to the dip side of the roadway, so that methane migrates to the roadhead area where it can be dealt with more readily than if it is at blind end of the face. Roadway conditions are also likely to be better if the waste area is to the dip side. Faces at Prince are easier to develop to the dip, and while coal would have to be conveyed uphill, the curved AFC has sufficient power for this task.

5.3.9 Panel Length

The primary restrictions on the length of panel which can be mined are based on the length of single entry that can be effectively ventilated, and the need, for safety reasons, to have no intermediate belt conveyor drives and transfer points in the single entry roadway.

Experience at Prince Mine has shown that the maximum single roadway length that can be safely ventilated is of the order of 1000 m. For the purposes of this study, this has been taken as the panel limit.

The type of In-Seam modular belt conveyor proposed for the single entry system is based on a 120 kW motor drive to which one or two

motors can be used. With the panels laid out such that the face retreats to the dip, a single 120 kW motor is more than sufficient to transport the 990 tph peak capacity expected from the face. The maximum length at this capacity with a 120 kW drive motor ranges from 1100 m in the northern end (shallower gradients) to 1300 m in the steeper southern end of the mining area. Gate belt power is thus not the limiting factor.

5.3.10 Seam Height Mined

It is common practice at the Prince Mine, to extract the full seam height on the western side of the main deeps. It has been assumed that this practice will continue in the single entry mining area. Seam height in the single entry mining area averages around 2.3 m.

5.3.11 Single Entry Roadway Width

The roadway width is dictated by the width necessary to accommodate the equipment in the roadway (especially in the roadhead area) and by strata control considerations:

Equipment requirements indicate that a width of not less than 5 metres is necessary.

Strata control considerations show that this width is acceptable provided the coal sides of the roadway are kept tight to the support legs. Since this is not always possible, it is considered that safety would be considerably enhanced if rock bolts are utilized between the steel sets as is discussed in Section 5.4.

A roadway width of 5 metres has thus been used for the purposes of this study.

5.3.12 Access

The selected mining area lies to the west of the six main deeps and to the north of the return air shaft (Figure 5-16).
Since the three main deeps (#1, #1A, #2) adjacent to the mining area are both return airways, an intake airway will have to be created.

It is suggested that a cross cut be driven from #5 deep (intake) crossing #4 deep (conveyor roadway) from approximately 50 m outbye #1W longwall tailgate, to a point 30 m beyond the #1A deep. This would involve the construction of overcasts over #1, #1A and #2 returns, or in order to reduce leakage, consideration could be given to driving this cross cut in rock above the main deeps, thus

avoiding the need to construct overcasts. A new roadway should be driven, parallel to #1A deep and leaving a 30 m pillar between them, to intersect the northern airway to the return ventilation shaft. A separate ventilation circuit would thus be established for the single entry faces.

Mining should commence with the face closest to the return air shaft, so that mined out faces are always on the outbye side of the operating single entry face.

A cross cut (with ventilation doors) could be excavated about mid-point between #1 deep and the new roadway, to provide access for materials supplies, or these could be delivered via the return roadway to the upcast shaft.

Coal would be conveyed down the dip in the new roadway and transferred to the main slope conveyors in #4 deep, by a short conveyor in the new cross-cut adjacent to #1W longwall face.

5.4 SUPPORT

5.4.1 General

Support forms an integral part of any mining method. It can be either natural (rock) or artificial (e.g. steel sets, bolts etc.). Because of the very different strengths involved, natural support tends to be used where regional stability is in question, while artificial support is restricted to local stability problems. The following discussion deals with local stability of working areas in and around single entry extraction areas. Artificial support will therefore be the main requirement.

Though the support installed in a single entry panel will be similar to that installed in the more conventional longwall extraction, more stringent requirements have to be met. This is due to the single access that exists to the working face and the consequencs of any ground instability in this access.

Discussion and assessment of support requirements can be conveniently divided into three areas based on the length of time the opening has to function, its geometry and the induced stresses around the opening. The three areas are:

- the Access Roadway;
- the Mining Face; and
- the Roadway/Face Intersection.

Before assessing the specific support requirements for each of these three areas, it is pertinent to examine the stresses that can develop around a single entry extraction and to review the resultant strata behaviour (an outline of the distribution of vertical stress within inter-panel pillars is given in Section 5.3).

Experience has shown (Wilson, 1980) that the roof above a total extraction panel face can be divided into two zones, the lower roof which caves into the waste, and the upper roof, which although it may develop fractures, remains intact and gradually lowers, compressing the caved material below it. A cross-section through a typical face is shown in Figure 5-17.

At seam level, the first increase in stress is detectable about 100 m ahead of the face. The stress gradually rises until a few metres in front of the face where it reaches a peak of about four times the cover load. At this point coal or the immediate roof begins to fail and the stress falls off rapidly. Across the working area, the stress is supplied by the supports. Behind the supports the lower roof caves, and the stress gradually builds up as the upper roof settles down on the caved material. Providing the area of extraction is sufficiently large, eventual cover load will again be reached. A widely held conception of the distribution of vertical stress is given in Figure 5-18.

For generally weak roofs the high compressive stresses that exist in the vicinity of the abutments are sufficient to cause failure of the roof strata. Because the lower roof strata in the mined area is in tension, gravitational collapse of the intensely fractured roof strata can occur. The collapsed material is not capable of transmitting any significant shear stresses, therefore the magnitude of the compressive stresses is limited and does not increase proportionally with the mining span.

The purpose of any support system, whether installed in roadways or at the face is not to counteract the mining induced stresses described above, but rather to contain the ground within the various "yield" zones in such a manner that mining can be carried out safely. In coal mining generally, the principle has been to install passive support which is able to withstand the loads imposed on them by the failed ground. Recently there has been an important shift in emphasis in the design of support systems. Rather than try to "hold up" the ground, the support is designed to perform more actively and enhance the self supporting characteristics of the rock itself.

Both approaches to support design around single entry panels have been examined as discussed below.

5.4.2 Roadway Support

Roof control and roof support in development and access roadways cannot be isolated, but must take into account the characteristics of the extraction system. For a single entry system the roadway forms the sole means of access and egress, therefore it is critical that the installed support can maintain safe conditions. Before examining, possible support systems, however, it is instructive to review current support practices.

In conventional longwall mining the most common roadway problem encountered is a deterioration of roadway conditions in a zone of high abutment stress some 10 to 30 m ahead of the face. Deterioration usually begins with extensive slabbing of the coal from the sides of the roadway, and the development of shear zones at the corners of the roadway. The support installed therefore, must be able to contain any broken ground that may result from the abutment stresses and also be able to accommodate the induced deformations. Conventionally this support has been passive, tending to contain failed ground, rather than help the ground to sustain its own self supporting characteristics. Table 5-3 lists some of the typical gate road supports used for different longwall extraction systems in European coalfields; while Table 5-4 lists the comparative support installed in single entry panels. The last entry in Table 5-4 is the support installed in Prince's #6W retreating longwall panel and is given for comparison.

Inspection of the two tables indicates that little difference exists between the support installed along roadways into longwall extractions and support installed along roadways into single entry extractions. Nor would there appear to be any indication that the support installed along Prince's 6W panel is atypical when compared with experience elsewhere.

The most elementary approach to design of roadway support is to use precedent; that is to apply support methods that have worked elsewhere under similar conditions. There are two sources for this information. One is Prince's own operating experience with gate road stability and support performance during longwall extraction; the other is experience gained from single entry extractions elsewhere. For example, the support along the maingate to Prince's #6W retreat panel consisted of 0.15 m x 0.15 m x 4.27 m long RSJ's with pin jointed steel legs installed on 0.9 m centres, together with bracing and timber lagging. This support density was found to be able to contain the zone of "yielded" ground that surrounds the drivage. Similar types and densities of support have been used along single entry panels at comparative depths at other mines (Table 5-3). Given that the potential area at Prince for single entry extraction is at a shallower depth than panel 6W and also at a shallower depth than the other specific cases quoted (60 to 100 m

cover compared with 230 m), experience dictates that the use of a similar support types and densities to the current longwall practice at Prince would provide acceptable coverage for the single entry access roadways.

A more rigorous method for assessing support requirements has been proposed by Wilson (1983) in which the dimensions of the yield zone in the roof of the roadway are estimated, based on the precept that the roof will behave as shown in Figure 5-19. The minimum vertical support pressure required can then be estimated by substituting the appropriate mechanical properties of the rock mass, Figure 5-20. As indicated in section 5.3.4, the value of the stress factor k (a function of the angle of internal friction of the rock mass ϕ) has been assumed to have a value of approximately 4. Thus for a 5 m wide access roadway, minimum support pressures of between 0.04 and 0.05 MPa are indicated. Such a pressure would be afforded by the support system suggested by experience as described above; that is steel sets capable of withstanding about 15 to 20 tonnes per leg approximately on 1.3 to 1.5 m spacings.

Though these two approaches will determine a workable solution to support, they may not necessarily result in the most technically appropriate, or economic support method, relying as they entirely do on the passive support of the failed rock. As has been mentioned previously, the design of coal mining support is tending towards the use of "active" systems that will enhance the self supporting characteristics of the rock mass, as opposed to passive systems that tend to hold up any failed ground. Because the rock is helped to support itself the result is usually a significantly cheaper support, both in terms of costs of consumables and cost of installation. This approach has gained wide acceptance in the metal mining industry and has been used with success in both the Australian and American coal mines.

As stated above the aim of any rock reinforcement is to enable the rock strata to support itself, that is, to utilize the inherent strength of the rock mass as much as possible. The purpose of the support is thus to increase the competence of the roof strata to achieve full stability after an opening has been made.

The commonly accepted modes of roof support are: suspension (of the weaker layers from a competent layer), beam building (by bonding and friction effect in the layers of the roof) and the keying effect (by bolting the planes of weakness). In the suspension principle it is assumed that the rock bolts are so spaced that their combined bolt capacity is equal to the dead weight of the strata that would tend to fall into the opening. In beam building, the purpose of rock bolting is to reinforce the rock so that it will become a part of the total structure supporting the opening. The reinforced layers act as a single beam capable of supporting itself

and the overlying rock. In stratified and jointed rock the bolts create a principal compressive stress normal to the free surface of the opening. This, in turn, creates a zone of rock which acts as a structural member capable of providing its own support. Although the rock bolts form a beam, the basic action is still essentially that of an arch.

Unal (1983) has developed design charts for roof support in coal mines. Figure 5-21 shows his proposed design chart for 16 ft. (5 m) wide roadways. The rock mass rating for the immediate roof at Prince has been estimated to be in the range 40 to 50. According to Unal's chart, Figure 5-21, the quality of roof would require 1.2 m x 1.5 m bolting pattern with sets placed every 3 m.

Because, however, of the single access to the proposed single entry system, a closer bolt spacing of 1 m is recommended together with strapping placed between bolts across the width of the drive. Wire mesh should also be installed in conjunction with the bolts to contain any small pieces of loose ground. A possible support layout is given in Figure 5-22. Though Figure 5-21 gives guidelines for the use of either mechanical or resin bolts, mechanical anchor bolts are not recommended, since experience throughout the mining industry (both coal and metal) has found that only about 30% of mechanical anchors installed are effective. The most appropriate bolt type is considered to be either a full column dowel (using resin cartridges) or Atlas Copco's Swellex friction bolt. This latter bolt can be installed quickly, and gives instant anchorage and is well suited for incorporation within a completely mechanised bolting programme.

Two approachs to support design have been discussed above, resulting in two different support types. Initially it is recommended that current practices may be used for any single entry roadways supplemented by rock bolts between the steel sets. As experience is gained with the method however, it is believed that set/arch spacings can be increased. The potential exits for reducing the number of sets/arches required by at least half, if not ultimately, altogether.

5.4.3 Support - Operating Face

Much debate exists as to the estimation of support requirements and the sizing of the powered support system along the coal face. Though numerous methods are available (Peng 1977, Smart 1987, Wilson 1983), the final face support generally evolves through a mixture of calculation and trial and error.

Experience has shown that by and large the support required at the face is dependent on the coal roof. Where a strong competent

roof rock is present, such as sandstone, there is a tendency for large detached blocks to form and perhaps cantilever over the shields. In these instances relatively high thrust is required, both to provide a safe working environment and to induce local caving. On the other hand where weak rocks are present in the roof, there tends to be caving immediately behind the face line. The supports then have to contain the immediate caved material. In this case excessive thrust can cause a deterioration in face conditions.

Again precedent is a useful starting point. Table 5-4 lists some of the support systems used in single entry panels. With perhaps the exception of the Gretley Mine in Australia, these panels have operated under shale or mudstone roofs not dissimilar to the expected conditions in Prince. This would suggest that shield capacity in the range of 300 t to 400 tonnes may be appropriate. This compares with the capacity installed in Prince's 6W longwall retreat panel.

A more rigorous approach is to determine the weight of the detached block of ground immediately above the face supports. The size of this block is a function of the immediate roof and the amount the caved ground bulks. At Prince, the geologic conditions present in the potential single entry area indicate that the caving should occur immediately behind the face support line, this caved ground is expected to bulk up to 1.5 times the extraction thickness. Thus the height of the detached block is some 3.5 m. Assuming a unit weight for the roof rock of 0.023 MN/m^3 gives a minimum support load of 0.181 MN/m^2. Applying a suitable factor of safety (2.0) and allowing for potential losses in the hydraulic system ($\approx$ 1.3 times load) results in an estimated setting load density of 0.2 MN/m^2. Yield load densities are then estimated as 1.25 times the setting load density, that is 0.25 MN/m^2 or 26 t/m^2. The present supports on #6W face are at a density of 59 t/m^2.

The powered supports already in use at the Prince Mine (Hemscheidt - 2 leg 320 t shields) can thus be used on the proposed SESLR face. Ideally the supports should be designed for the specific application, but since they will be working at a lesser depth than is presently the case, all that should be necessary is a lowering of the setting and yield pressures, to suit the strata loadings.

The main considerations are the operating height range and capabilities of mining a 1 m web. All supports on the face should be the same (with the exception of the canopies of the three roadway supports). The front cantilever must be able to provide support immediately after the machine has passed cutting at roof level from the main gate to the blind end. The sequence of cantilever operation could be machine initiated. The proposed operation would be such that the machine would return to the main gate cutting the

remaining floor and on completion of the cut (the machine being fully into the main gate), the AFC could be pushed over completely in line, then the supports could advance sequentially. The whole operation could be performed from the stageloader with no manpower on the face.

It is realized that the vast majority of powered roof supports are operated on a one web back method, this allows immediate roof support of the newly exposed roof with the main canopy rather than complicated front cantilevers. However this means that the supports are moved over behind the shearer operator as he is cutting towards the blind end, a situation which is not acceptable in single entry mining.

When difficult roof conditions are encountered support close to the face is important therefore the incorporation of fully loaded forward beams in the design is a major requirement.

An engineering consideration for powered supports is that the setting load density prior to the cut should be equal to the yield load density after the cut - on average within the design parameters of 2 and 4 leg shields this requires a setting load to yield load ratio of 80%.

Electro hydraulic control is essential for the application of the SESLR system, since it offers:

- Safety
- Simplicity of Operation
- Speed of operation
- Flexibility
- Improved Roof Control
- Reliability

With shearer cutting rates in excess of 10 m/min achievable, the support must respond accordingly. With the latest generation of gate end computers the system could be programmed to control, depending upon the mining circumstances, any of the following available options.

- Adjacent individual service control
- Adjacent sequential control
- Remote push button control
- Remote sequential control
- Machine initiated control

The application of remote control takes another responsibility away from the operator and should consequently reduce fatigue.

Should the decision be made to acquire specific supports for the SESLR face, close liaison with the various manufacturers should be undertaken to provide features that could assist the operation and especially the transfer of the support from face to face.

For transportation the weight is important particularly if FSV's are being considered. For face transfer the lowest collapsed height and length for transport are site specific. (The Gretley SESLR face requested a support length of 4 m or less.)

Other technical details specified should include:

- 1 m web depth
- Floor loadings
- Roof density at yield (tonnes/m^2 of face area)
- Ventilation area
- Tip load
- Cave loading
- Maximum pressure
- Circuit pressure
- Support rating
- Main gate layout
- Blind end layout
- Material properties
- Prototype testing date

5.4.4 Support - Roadway/Face Interface

The face roadway intersection is perhaps the most critical of the support areas, straddling as it does a zone of caving ground, a zone of yielding ground and a zone of high stress abutment. According to Table 5-3 the most common support is a 4 leg 280 t chock shields.

Experience has shown that the support in the intersection area should be approximately equal to two-thirds the faceline requirements (Isaac and Smith, 1986). This would imply a setting load density of 0.13 MN/m^2 and a yield load density of 0.17 MN/m^2, (18t/m^2).

The immediate roof in the designated mining area is a friable coaly shale, expected to be about 200 mm thick. As discussed in section 5.4.1, allowance has been made for this to be mined as the roadway is driven, but this bed will form the immediate roof on the face. This allows the roadway support beams to be above the top of the face supports, thus permitting the three roadhead powered supports located across the 5 m roadway to operate at the same level as the face supports.

These three anchor supports would be indentical to the face supports except that they would be equipped with extra long rigid canopies capable of supporting all the roadway roof beams which have their face side legs removed, plus the next roof beam which is due to have its leg removed. This also ensures that the area over the roller curve pan of the curved AFC is adequately supported. In addition, hydraulic props set in the centre of the roadway under each beam can be used if extra support is necessary.

5.5 EQUIPMENT- DEVELOPMENT

5.5.1 Excavation

The drivage of roadways of rectangular cross section, in coal or coal and softrock can be undertaken by continuous miners, In-seam heading machines and roadheaders. There are more than 20 manufacturers producing over 80 different models. The Prince mine is currently using Dosco Dintheaders to drive gate roadways and face lines. At the Phalen mine, the only other 'retreating' mine, the Westfalia VME, and Dosco LH1300 and Anderson Strathclyde RH25 roadheaders are also used.

Since the immediate roof in the single entry area at the Prince mine is friable, and since tight effective support is essential in the single roadway (as discussed in Section 5.3) the roadway drivage machine should be of a type which eliminates overcutting at the side of the roadway beyond the side of the support legs (Figure 5-23). It should also be noted that in UK mines working single entry faces where heading machines leave cusps at roof and floor at the roadway sides, the UK Mine's Inspectorate have insisted that these cusps have to be supported. This complicates support handling at the face/roadway area on the retreating face.

In addition, the machine has to be capable of:

- high rates of drivage (in excess of 15 m per shift);
- turning through 90° to drive the face line from the roadway; and
- easy dismantling and removal from the blind end of the face when face drivage is complete (unless it is to be used to mine the retreating face).

In order to achieve the high rates of advance required, consideration needs to be given to segregating the cutting and support operations. This can be done with the VME (or ESA or In-Seam Miner) by utilizing powered supports (with extended canopies) behind the

basic machine and setting steel sets and rock bolts behind the machine (Figure 5-24).

The Westphalia VME is the only machine which meets the 'no cusp' requirement and most of these other requirements. It also has the capability of mining the retreating short face.

Ideally the curved conveyor carrying the VME should be of the heavier duty heavy section type (EKF2) so that, if required, after driving the face line, the conveyor can be left on the face for the retreat mining phase. The haulage chain and motor of the VME would also need to be of greater strength (26 mm) and power to cope with the added length. Figure 5-25 illustrates the sequence and positioning of conveyors for roadway drivage, face line drivage and retreat mining.

As mentioned previously, the VME should be equipped with anchor supports (3) preferably of the Desford 2 leg type for machine advance, rather than the 2 staker legs normally supplied with the machine, as the positioning of the latter is so inflexible that the roof beams of the roadway support are frequently damaged.

The cutter drums should also be equipped with back face pick flushing to control the dust make.

If the roadway and face line are driven with a dintheader, extra care will have to be taken to prevent overcutting at the side. Like the VME, the dintheader can turn off the face at 90° and drive the face line. In this instance, the AFC can be installed behind the dintheader, which is narrow enough that it can be flitted off the face. It can also flit down the roadway alongside the conveyor provided FSV's are used (no rail track) for materials supply. At Wistow, where a BJD Heliminer was used to drive the roadway, and locomotives were used for transport, it was necessary to remove the belt and structure before the continuous miner could flit out of the heading.

5.5.2 Support Setting

Neither the VME, Dintheader or the Eickhoff ESA150 permit supports to be set close to the face whilst the machine is still cutting (only the Dosco In-Seam miner permits this).

The machines have therefore to be equipped with girder setting devices for holding the roof beams tight to the roof whilst the vertical legs are clamped to the beam and set tight on foot blocks. These would be an integral part of the anchor pushing system of the VME, or attached to the body of the Dintheader.

Rock bolting drills should be either mounted on the rear of the anchor chocks, or be light weight hand stoper type drills operated as close to the machine as possible. The high pressure water pump for setting the Swellex bolts could be mounted on the rear of the VME or the monorail pantechnicon carrying the switchgear and monitoring equipment.

5.5.3 Coal Clearance

The gate conveyor used to transfer the coal from the heading machine to the main district conveyor should be identical to the belt conveyor required for the mining of the retreating face. This should be at the rated capacity for the face and be fully equipped with automatic loop take up and belt reel station as is described in Section 5.6.4 following.

5.5.4 Materials Supply

The expected life of a 1000 m panel, including development, installation, mining, salvage and transfer is of the order of 4 months. In addition, the advisability of having the minimum amount of services and equipment in the single entry roadway, indicates that the FSV is the most suitable materials handling unit. The Eimco 913 20t Heavy Duty transporter has the correct dimensions and power to be able to handle, not only the day to day supplies needs, but also the transport onto the face and the salvage off the face of the powered supports.

The use of the FSV eliminates the need to install and later salvage the rail track or monorail track currently used in CBDC mines for materials handling in gate roads, with resultant savings in both time and materials.

5.5.5 Communications and Monitoring

The equipment and systems proposed for use for monitoring the retreating face and roadway, and for maintaining communications, should be also installed and operated in the roadway and face line as these are driven. These are discussed in more detail in section 5.6.6 and 5.7 (Monitoring) and 5.6.7 (Communications).

5.5.6 Power

In a similar manner, the power supply system used for the development phase should be capable of being extended with minimum

modifications to accommodate the requirements of the mining phase. This is dealt with in section 5.6.8.

5.6 EQUIPMENT - PRODUCTION

5.6.1 Coal Cutting

The most effective and productive single entry systems are those which use separate machines for development and mining. The system proposed for the Prince Mine is based on the use of separate machines for each function.

In selecting the type of machine to be used, recognition has to be given to the excessive frequency with which the AFC has to be advanced. At mines using double ended shearers, considerable trouble was experienced with the pan joints on the AFC due to the very frequent snaking of the conveyor and the need for the DERD shearer to cut on the snake since the machine was too long to get into the roadway. Attempts to overcome the joint problem by welding pans in groups of 3 only reduced the problem. On face lengths of 25-30 m, the frequency of snaking will increase as will the joint problems.

In seam heights of around 2.3 m, and for 25 m length faces, the most applicable machine would be a short single ended ranging drum shearer (SERDS). This not only enables the AFC snaking problem to be eliminated, but removes the need for the shearer to cut 'on the snake' and ensures that the powered support operator is always outbye the supports being advanced. The tendency is also towards higher power for increased reliability rather than increased production since major breakdowns of the shearer are even less welcome on single entry faces. With the higher power this limits the choice to three companies, British Jeffrey Diamond, Anderson Strathclyde and Eickhoff.

The non-snaking of the AFC, and the facility to advance the AFC in one straight push requires the shearer to be fully into the gate to minimize sumping in. The total length of the machine including drum should not be greater than 5 m. Suitable single ended machines include (Figure 5-26):

Anderson Strathclyde AM500 - 300 kW - 4.7 m
British Jeffrey Diamond ACE - 375 kW - 5.0 m
Eickhoff ESA 150 - 150 kW - 4.8 m
Eickhoff ESA 300 - 300 kW - 4.8 m

To enable the machine to traverse the roller curve only three shoes will be necessary, 2 goaf side and 1 face side, so as to eliminate any obstruction to the coal stream, at the curve section.

The proposed cutting operation for a short single ended shearer would be to cut the top coal from main gate to the blind end and return to the main gate taking the bottom coal. The AFC drive frame and shearer would then be moved over simultaneously in line with the rest of the AFC and the operation repeated.

For application at Prince Mine, the drum diameter should be 1.7 m with a 1.05 m web. This provides good loading characteristics and enables a rotary air circulation dust suppression system (RAC) to be fitted to the cutting drum (Figure 5-27). In addition back pick face flushing should be incorporated. These would necessitate the installation of a boost pump (Pitcraft or similar) on the machine to raise the water pressure to 7 Mpa, and thus provide effective dust suppression and ventilation of the cutting area.

On single entry installations the shearer haulage system and associated hardware are exposed to higher degrees of wear to that encountered on longer faces, because the machine travels more frequently over the same section, it is, therefore, important to install a heavy duty haulage track. The cutting speed would depend upon the strength of the coal and power of the shearer, and from previous experience this would be expected to range from 8 - 12 m/min. Consideration should also be given to the electrically driven haulage since this gives greater reliability and eliminates some hydraulic oil usage.

Microprocessor based control and health monitoring is an essential feature to ensure a high degree of reliability. Areas to be monitored include hydraulic haulage oil pressures temperatures, water pressure and temperature, motor current, winding temperature, and pilot circuit diagnostic facilities.

5.6.2 Face Conveyor and Stage Loader

Most conventional longwall faces are equipped with a separate armoured face conveyor and gate stage loader, however, recent developments in the use of roll or curved sections for insertion into the standard in-board chain AFC have led to the successful elimination of the face conveyor drive unit. Curved AFC's have been in use for more than 10 years on faces ranging from 50 m to 350 m in length.

In single entry working, it is highly desirable to eliminate as many items of equipment from within the panel as possible. The short length of face (25 m) and the short fixed length of conveyor in the

roadway (stage loader length - 25 to 30 m) present an ideal opportunity for the use of the roller curve conveyor.

Normally face output is invariably focussed on the output capabilities of the cutting machine. In longwall and single entry installations, production calculations must be based upon the ability of the face conveyor (and gate conveyor) to remove the coal from the face.

In the single entry system under consideration, with a SERD shearer as the cutting unit, all the cut coal has to pass through the underframe of the shearer. The possibility of coal flow restrictions in this area, and the possible resistance to flow have to be taken into account when determining the power required to operate the roller curve AFC.

In determining the size of the AFC, the following have to be taken into account:

- capacity;
- reduction of downtime; and
- material size and need for a coal sizer.

It is not necessary to match the shearer output one for one with the AFC as there are inherent delays in the cutting cycle that allow the conveyor to clear the coal. Normally the AFC should be capable of handling 90% of the peak output of the shearer. In this case, a rate of 990 tph (from section 5.9) is required, which demands a drive power of 200 kW for the 60 m length of conveyor proposed; (including negative gradient).

One of the major causes of delay with AFC's is difficulty in starting the conveyor due to insufficient power, especially when the conveyor is fully loaded. The elimination of fluid couplings and the use of direct on line two speed motors of suitable size has virtually eliminated this problem. Two speed motors give better starting characteristics and greater reliability and are proposed for the single entry system. However, their use requires consideration of several other factors. These are:

- They are more demanding on the electrical supply system. A capacity allowance of ±20% on the rated AFC, power should be made, and the system engineered to provide the maximum voltage at the face under starting conditions (minimum voltage drop).

- The AFC chain should have a minimum 2:1 factor of safety at the low speed operations.

- Chain pre-tension is directly related to the power applied, and solid (one piece) sprockets should be utilized.

- Two speed motors should always be used for heavy duty and demanding applications.

The 'stage loader' section of the curved AFC should incorporate a number of articulated line pans which permit the discharge end of the conveyor to be lined up with the tail end of the gate conveyor.

Coal sizers are in use on the longwall face at Prince Mine located on the stage loader. It is assumed that they would also be required in the single entry system, and would be mounted on the gate road section of the curved AFC.

Roller curve AFC's are in use in Europe and USA and have been successfully used in single entry faces at the Stolzenbach Mine in West Germany for over 5 years. In addition to eliminating a drive unit, they also eliminate a transfer point which results in less dust and elimination of delays due to blockages at that transfer.

Roller curve conveyors are made by Halbach and Braun, Westfalia, Dowty Meco and Wultex with the former having by far the largest share of the market and the longest experience. Figure 5-28 shows a typical layout.

AFC line pan designs fall into two categories, composite construction and cast construction. The former comprises more individual bolted components, whilst the latter has many of the accessories cast on. Cost is often the deciding factor and favors the composite line pan, however, in aiming at a working life of at least 2 Mt, deck plate thickness and material, and the type and strength of pan connectors and the deck plate jointing system are major considerations. Standard ramp plates would be fitted on the face side but goaf side furnishings are specials incorporating, in addition to the chainless haulage track, machine trapping, cable handler and tray and powered support attachment, the face ventilation duct. Figure 5-29 shows a typical section through an AFC highlighting the ventilation ducting which should be at least 0.3 m^2 in section. It is understood that the only supplier of these special furnishings is Pitcraft.

5.6.3 Gate Conveyor

The belt conveyor in the gate roadway should be installed as the roadway is driven, and sized and equipped to be able to handle output from the retreating face.

For ease of handling, bearing in mind that it will have to be moved every 3 to 4 months, the conveyor drive and loop take-up should be of modular skid mounted construction, modules being connected by taper pin joints, and designed for in-seam applications. Structure should be of the boltless type for quick erection and dismantling and the return end should be a single rigid unit.

The most critical aspect of the conveyor system is its ability to cope with the rapid advance and retreat rates imposed by the single entry development and retreating face.

This is achieved by having a loop take-up unit with a belt capacity of 100 m, coupled to a powered belt reel station. The loop take-up is fully automatic being electrically operated using PIAB tensioning equipment. This latter unit continuously monitors the belt tension maintaining it between preset minimum and maximum settings. In the drivage phase, as the tail end is advanced, the loop take up automatically releases belt into the system, whereas in the retreat mining phase, belt is drawn into the loop take up automatically as the AFC and gate conveyor return end are moved.

In the retreating phase, the curved AFC (or stage loader) discharge is permanently attached to the gate belt conveyor tail end, though articulation between the two units is still permitted. Four steering and staking rams are incorporated on the tail end structure to maintain belt alignment. These are under the control of the roadhead/consol operator.

The belt reel station, incorporating hydraulic belt clamps and a work table, enables two men to remove or add 50 metres of belting in fifteen minutes. (Figure 5-30).

Historically, properly maintained belt conveyor systems have provided one of the most accident-free methods of transporting bulk materials. However, this is the result of attention to safety of operating and maintenance personnel and to the incorporated of monitoring and control systems. These systems are now sufficiently reliable that belt conveyors can be operated unmanned with remote control and monitoring being undertaken from the surface control centre.

The monitoring and control system must include the following:

- Emergency stop switches located throughout the length of the conveyor
- Pre-start warning device (audible)
- Limit switches particularly in the take up, also lateral limit switches for belt movement

- Torn belt protection
- Slip protection
- Sequence protection
- Overspeed protection
- Chute blockage and full bin protection
- Overrun protection
- Drive unit protection, including bearing temperature and oil level monitors
- Infra-red detection along the roadway.
- Guards around the drive pulleys, take up, return and head end pulleys
- Protection beneath conveyors, and
- Lighting at critical areas

Certain factors have to be established in the design of a conveyor. These include:

- the output to be conveyed;
- the profile of the conveyor; and
- the approximate density of the mineral to be conveyed.

The tension produced in a belt is a function of belt width, belt speed, horse power transmitted and the type of drive. Thus it is essential that when the first three parameters have been determined consideration be given to selecting a suitable type drive.

The assumptions and factors used for this study are as follows:

Peak capacity	990 tph
Belt width	1050 mm
Belt speed	2.4 m/sec
Troughing angle	35°
Installed power	112 kW
Loop storage	100 m
Gradient (in favour)	0.5° to 1.5°
ROM Coal density	0.88 t/m^3
Maximum length required	1060 m

Based on the above criteria, the maximum length achievable is 1100 m for the 0.5° case and 1300 m for the 1.5° case. A single 112 kW conveyor drive is thus adequate for the single entry panel.

The majority of the single entry faces in operation are using the FSW In-Seam Modular conveyor drive unit, automatic loop take-up and belt reel station as this has been specifically designed for fast retreating faces and rapidly advancing drivages. Other suitable, but not modular, conveyors are available from Dowty Meco, Huwood, FSW, and Anderson Strathclyde.

5.6.4 Powered Supports Pump Station

In keeping with the requirement to reduce the amount of equipment in the single entry panel, and to reduce the frequency of transfer of equipment, it is proposed that the pump station be located outbye the single entry panels, and in such a position that it could service four single entry faces before it becomes necessary to relocate the pump station.

Remote pumping stations are being successfully used on many conventional and single entry longwall faces, and remove the need to transport hydraulic fluids in the single entry panel.

In order to maintain the efficiency of the system and keep pressure drop to a minimum, high pressure seamless piping should be used to service the face. A relief valve would have to be fitted in the return line, since the faces will be higher than the pump station, to prevent back flushing of the return line (Figure 5-31).

The standard pump is the Hauhinco EPH-3K125 capable of delivering 200 litres/min at 350 bar. Two units should be located in the remote pump station which will be at a maximum distances of 1550 m from the farthest of the four faces it would service. The pump station could be located in the side of the main intake roadway for the single entry mining area. Figure 5-32 shows a typical remote pump station containing:

3 - 200 l/min 350 bar Hauhinco EPH - 3K125 pumps.

2 - 1500 litre tanks with integral 200 litre emulsifier tanks and auto flush filtration system.

A similar 2 pump system is proposed for the single entry area.

Assuming a 60 mm dia pressure line, and a 75 mm return line, maximum pressure drop to the farthest face is calculated to be approximately 4 bar (60 psi).

The use of special victaulic couplings enables the ranges to be rapidly shortened back, however, care in handling pipes is essential in order to maintain a clean dirt free system. This is especially necessary with the electro-hydraulic control system used on the powered supports.

5.6.5 Monitoring and Control

The need for effective monitoring and control of the environment and equipment in the single entry panels has been discussed earlier in this report, and bears repeating since the risks involved in single entry working are greater than in conventional longwall working and safety cannot be compromised.

Environment

Typical of the major items of monitoring equipment required for the single entry system are:

1. BM3 CH_4 monitor which has the provision to shut off the electrical power.

2. BA5 air velocity monitor which is essential to ensure adequate ventilation.

3. BC01 CO monitor for detection and monitoring of carbon monoxide and other combustion products. This is extremely important in the location and control of all underground fires.

4. Trolex TX 4455 F1FF1 vibration monitoring system for all auxiliary fans.

Specific monitoring layouts for development and retreat mining are described in section 5-7 (Ventilation).

Monitoring systems, type and location should be written into the Manager's Scheme for the Mine. Cut off levels for each installation have to be agreed upon with the Inspectorate. Methane detectors must be interlocked to the electrical system, such that if levels require isolation this must not affect the ventilation system unless gas is in the immediate vicinity of the fan, (see section 5-7).

Wherever practical the condition monitoring and the essential warnings and alarms should be relayed to surface as well as being displayed at the inbye and outbye ends of the roadway. In all instances the information should be displayed at places which are continuously manned.

Equipment

Electronic control of the powered supports permits constant monitoring so that faults and delays can be corrected in the shortest possible time. The system facilitates better utilization and availability giving better management of the face activities.

Premature failure and poor performance of pumps and hydraulic equipment can be attributed to fluid deterioration and contamination. Some mines are using synthetic fluids replacing the conventional 95/5 emulsion. The advantages sought after are:

- improved fluid stability giving better control of fungus and bacteria
- reduced filtration failures
- greater system reliability

The hydraulic fluid must be of an approved type and fire resistant. Constant monitoring of the fluid on a regular basis for emulsion percentage and contamination is essential, since inverted emulsion (60/40), which is used extensively underground for its fire resistant properties, can lose both its fire resistant properties and lubrication performance with $\pm$ 5% of water.

Underground monitoring has been focused specifically on electrical and hydraulic equipment but not all manufacturers have yet built into their equipment permanent and accurate means of condition monitoring. For example, power transducers are not permanently installed in underground gate end boxes.

Condition monitoring of hydraulic equipment and systems consisted of only flow and pressure transducers using chart recorders which had to be connected into circuits with the inevitable contamination in the underground environment. The orifice test unit is now a standard feature on powered support power packs, roadway drivage machines and power loaders. The test unit provides an accurate assessment of pump, motor, control circuit, main relief and pump relief performance.

Stall devices are recommended for monitoring power loader haulage forces and clutch setting levels on chainless haulage systems. A recurring problem underground is the inaccessibility of oil level plugs and site glasses. Passive oil level probes are now available using prismatics and fibre optic transmission. The major advantage is that the probes can be fitted with minimum modification to existing equipment.

Regular oil condition, wear and debris monitoring either on site or by independent laboratories have drastically reduced major component failures. Savings on just one shearer in the UK over its productive life were $144,000. The totalinvestment in routine condition monitoring equipment was $34,800 giving a net saving of $109,200.

The Managers Scheme for the Mine should require internal inspection and testing of electrical apparatus at stipulated time intervals. Future monitoring equipment should enable condition monitoring to be applied without the costly and labour intensive current procedures which yield very little reward.

5.6.6 Communications (Safety Features)

Efficient communications are an essential part of any mining system, and have become a mandatory part of single entry face approvals in the UK. These include not only verbal communications, but also audible warning requirements.

Pre-start warning must be fitted to the power loader, powered supports, AFC, lump breaker and gate belt. Audible warnings, in both directions should be incorporated on any power monorail system and on FSV's. A system similar to the Davis Derby MK11 SIVAD provides the necessary coalface control, signals and communications.

The communication system to the district must be dedicated. Contact must be maintained between the district entrance, the inbye coalface and surface. Provision should be made for intermediate communication points at 100 m intervals along the roadway.

Communication equipment is site specific, however major emphasis must be placed upon the integrity of the cable under emergency conditions, and under total power failure communication must be still operational.

5.6.7 Electrical Power

The electrical power system has to be designed to tie in to the existing mine distribution system, which falls outside the scope of this study.

However, an outline of the requirements for the single entry mining area is given below.

Essentially, power is required at four locations.

- At the development drivage face. (Figure 5-33)
- At the entrance to the drivage. (Figure 5-33)
- At the retreating mining face. (Figure 5-34)
- At the entrance to the roadway serving the operating single entry face. (Figure 5-34)

The power requirements in each location are given in Table 5-5.

If the headings are limited to 1000 m in length then the need for an inbye transformer can be eliminated.

Codes of practice must be established in the case of interruption of the ventilation and/or presence of methane. A fundamental rule should be that the electrical power to the face shall be cut off automatically if either the inbye fan or outbye forcing fan is stopped for any reason.

The district could be supplied from 1000 KVA transformer located in the main intake. The independent supply to the 90 KW fan should be interlocked to the transformer and in the event of the fan stopping the transformer would trip isolating the district automatically. The fan switch and district section switches should be located on the intake side.

Flexible armoured cable would feed the section feeders. A monorail system located inbye should be designed to handle up to 300 m of cable to enable 200 m lengths of cable to be dropped out as required (Figure 5-35). The section feeders should be interlocked to the 37.5 kW inbye fan.

Recent developments include gate end boxes (Wallacetown) which have double outlet boxes which are independently controlled. A 50% saving in space is thus gained in equipment carried on AFC/stageloader.

Communication must be maintained at all times even during power failure.

5.6.8 Materials Handling

The materials handling system has two tasks to perform. Firstly the supply of materials to the drivages and the removal of materials from the retreating face and secondly the installation, recovery and transfer of the face equipment.

Experience on single entry faces has already shown that face equipment installation, recovery and transfer is most efficiently undertaken by FSV's. These machines which can be fitted with different attachments for specilized transportation tasks, are diesel or electric powered, and since they require no track, eliminate the need for the supply, maintenance and recovery of rail track. Figure 5-36 shows a typical FSV carrying a 4 leg 280 t chock.

Single entry faces and roadway drivage are operating safely and successfully with approved materials supply to the roadhead being provided by diesel FSV's. In most instances, this is on one shift only, with a short monorail system being used to handle materials in the roadhead area.

Typical of FSV's is the Eimco 913-20 Heavy Duty Transporter which has a carrying capacity of 20 tonnes and yet is only 2.5 m wide (Figure 5-37).

The use of FSV's and short inbye monorails is proposed for the single entry mining area.

5.7 VENTILATION

5.7.1 Basic Parameters

Since the entire single entry system will be dependent on auxiliary fans operating through ducting, and since it is imperative to ensure that emitted methane is diluted to safe and acceptable levels, the quantity of air passing through the single entry face should be the maximum possible within the physical constraints set by the mining conditions.

Thus, with seam heights likely to range from 2.2 - 2.3 m and a roadway width of 5.0 m, there should be ample room in the entry roadway to use 914 mm lay flat ducting, suspended over the gate belt conveyor. Over a length of 1000 m, this will permit a 90 kW ILR forcing fan to deliver approximately 8 m^3/s of air at the end of the duct. A reduction in the duct diameter to 760 mm reduces the quantity to around 5.8 m/s.

Measurements taken over a mid week period of 24 hours from the system monitoring 6W longwall face at the Prince Mine indicate that the methane concentration increased from an average of 0.09% in the intake roadway to an average of 0.21% in the return roadway outbye the face. The average quantity of air on the face was 17.3 m^3/s, giving an average methane emission rate over the 24 hours of 0.0208 m^3/s (20.8 litres/sec). During this period, the face

produced 6873 t of ROM coal, and the barometer was essentially steady. This equates to an emission rate of 0.26 m^3/t mined.

The ventilation and monitoring systems proposed for the development of the single entry roadway and the face line, and for the mining of the short retreating longwall face are described in the following sections.

5.7.2 Ventilation System - Roadway Development

The system most universally applied to the ventilation of roadway development is the use of a primary forcing system with a secondary overlap exhausting system at the heading face which includes an air filter unit for dust removal. The latter is generally essential since heading machines usually generate more dust than longwall face machines.

Figure 5-38 shows the proposed layout. The primary fan, 914 mm dia., located in intake air outbye the single entry roadway should be a 90 kW ILR fan forcing air through 914 mm lay flat ducting, the latter suspended over the gate belt conveyor. The ducting should be maintained close to the rear of the heading machine. This fan can be expected to deliver approximately 8.0 m^3/s at the duct exit 1000 m inbye.

A secondary fan should be located and maintained at least 10 m outbye the end of the forcing ducting. This should be a 37 kW ILR fan equipped with a microdyne type dust extractor, and exhausting air through spiral reinforced 760 mm dia ducting. In order to meet later the requirements of the face ventilation system, the fan should also be 760 mm diameter and attached to the ducting through an adaptor. This fan can be expected to exhaust at least 3.0 m^3/s from the heading. This quantity is sufficiently below that of the forcing system as to eliminate any tendency for recirculation and meets the regulatory requirements. The secondary fan and dust extractor could be monorail mounted for ease of advancement.

A monitoring system (Figure 5-38) should be installed which should be capable of extension to meet the requirements for the retreating face to be mined later (Figure 5-40).

This should include, as a minumum:

- BM3 (or similar) methanometers located immediately outbye the secondary fan, set to alarm at 0.8% CH_4 and cut off power to the heading machine at 1.25%.

- A TX130, BA5 or similar air flow transducer located in the forcing ducting close to the discharge point and set

to alarm at a minimum quantity determined by the Mine Manager.

- At the outbye end of the single entry roadway, CO and smoke detectors should be located.

- Both primary and secondary fans should be equipped with FIFFI vibration monitors, and indication of fan power supply status and fan 'running'.

It is anticipated that, after the establishment of the initial panel, ventilation ducting for the development would come from the adjacent retreating short face as the system is shortened back.

5.7.3 Ventilation System - Face Line Drivage

The maximum length of longwall face envisaged in the initial mining area at Prince Mine is 30 m. It is therefore feasible and safe for the secondary exhausting fan system to be used to ventilate the face drivage, the face ducting being located over the AFC, with the discharge from the forcing duct located at the roadhead area inbye of the exhausting fan as shown in Figure 5-39.

The primary fan system remains as described in section 5.7.2. The monitoring system would require the provision of an additional BM3 in the face heading and a TX130 in the exhaust ducting controlling the power to the face drivage machine.

The inclusion of a detailed monitoring system for the roadway and face line drivage is considered to be essential to emphasize the need for the highest standards of ventilation during the complete panel cycle; that is not only for the retreating short longwall face, but also during panel development.

5.7.4 Ventilation System - Short Retreating Face

The ventilation system must, at all times, be capable of diluting the expected methane emitted on the operating face.

As indicated in section 5.7.1, the average rate of methane emission from the face during normal mining operations is 0.0208 m^3/sec. for a shift output of 2290 t. The rate of production per shift expected from a single entry face is 1330 t (as shown in section 5.9.2) but the methane emission should remain the same at 0.0208 m^3/s.

If the total air flow returning down the gate is 8 m^3/s, the methane levels in that flow can be expected to be about 0.26% CH_4. If the flow on the face is 5.0 m^3/s, the methane level would be 0.42% CH_4.

Three potential forcing ventilation systems for use in single entry workings were described in section 4.2.7. Of these, the twin duct system is considered spatially unsuitable (in a 5 m wide roadway) and because higher ventilation quantities are not required. Similarly, recirculation is not required.

The system proposed for ventilating the retreating face is therefore based on the use of a single 914 mm lay flat ducting supplied by a 90 kW 914 mm dia. fan located outbye the entry to the roadway. This ducting delivers air direct to a 37 kW 760 mm diameter fan located on the stage loader or gate section of the curved chain conveyor. The secondary fan delivers air through lay flat ducting located in the steel ventilation duct which forms part of the AFC furnishings. This duct should have a cross-section of at least 0.3 m^2 and preferably larger. If required, some air from the forcing fan could be bled off before the entry to the secondary fan to assist with methane layer control at the roadhead. This should enable at least 5.0 m^3/s to be delivered through the face ventilation ducting to the blind end, and would facilitate the shortening back of the primary ducting.

The monitoring system should include (Figure 5-40):

- TX130 or BA5 air flow monitor at the discharge end of the face duct set to alarm at a minimum air flow set by the Mine Manager.

- BM3 methanometers located at the blind end of the face, the roadhead, and at the point on the face where experience indicates that waste flushing first occurs. These should be set to alarm at 0.8% and to cut off power at 1.25%. The blind end and mid face methanometers would cut off power to the shearer, whilst the roadhead monitor would cut off all power to the face except the ventilation system.

- CO and smoke detection at the outbye end of the single entry roadway, and

- Vibration monitoring (FIFFI) of all fans with indication of power status and fan 'running'.

All monitoring instruments in the face and roadhead area should continuously report readings to the control consol on the stage loader, and to the surface control centre. Monitoring equipment at the outbye end of the roadway and at the primary fan should display readings locally and at the surface control centre.

The monitoring and ventilation systems outlined above should be sufficient to ensure that the development and mining of a single entry face are conducted in a safe and controlled manner.

5.7.5 Methane Drainage

It has not been found necessary, to date, to introduce methane drainage at the Prince Mine to control the level of methane in return air flows.

If, in the operation of the single entry system as described, dilution of methane to acceptable levels does not prove possible, a number of options are possible.

1. Replace the 37 kW secondary fan with a higher powered high pressure fan.

2. Install twin ventilation ducts in the roadway with a 90 kW fan supplying each duct.

3. Resort to some system of methane drainage utilizing the multi-entry development system briefly discussed in Section 4.2.2.

5.8 MANPOWER

The current mining regulations applying to the CBDC mines, limit the number of men allowed in a single entry working place to 9 (this is due to be increased to 15 under proposed changes to the legislation).

Experience at other mines operating the single entry short longwall retreating system indicates that a 9 man limit is perfectly adequate except at times of installation and salvage/transfer of the face equipment when an exemption for 15 men is usually found necessary.

5.8.1 Development

Present development headings at Prince Mine using DOSCO Dintheaders operate with 10 man crew, including supervision, and have a 15 man exemption.

If the single entry development is driven with either the Westfalia VME or the DOSCO Dintheader, and supplied by free steered vehicles (FSV's), the manpower required should be:

Heading Machine	4
Materials Supply	2
Rock Bolting	2
Supervision	1
	9

Electrician and Mechanic would be on call shared with the single entry face being worked.

It is envisaged that the rock bolting crew would install the bolts immediately behind the heading machine, and also be responsible for the installation of pipes, ducting, conveyor structure and other services.

The gate belt operator, if required, is located outside the single entry roadway and is not counted as part of the single entry team.

The operation of the development has, therefore, to be undertaken under a 15 man exemption to allow for access into the development by management, safety personnel and electrical and mechanical staff.

5.8.2 Face Operations

The manning levels required for a short single entry face are considerably less than those necessary for a conventional retreating face.

The expected manning levels are:

Face Machine	2
Support	1
Roadhead/Consol	1
Supervision	1
	5

Electrician and mechanic on call and shared with the adjacent developing panel.

Materials transport usually requires a two man team on one shift only. Although several mines are operating single entry faces on 9 man limits, some are working with an exemption of 12 men to allow sufficient flexibility for management, safety, and maintenance personnel to have access without stopping face operations.

5.8.3 Summary

In summary, the manning levels for productivity purposes are:

Development

Heading Machine	4
Materials Supply	2
Rock Bolting/Services	2
Mechanic	1/2
Electrician	1/2
Supervision	1
	10

Face

Face Machine	2
Supports/Rams	1
Consol/Roadhead	1
Electrician	1/2
Mechanic	1/2
Materials Removal	2/3
Supervision	1
	6 2/3

5.9 PRODUCTION STATISTICS

The output expected from single entry short retreating faces using 300 kW shearers is based partly on experience cutting coal at the Prince Mine, partly on experiences at other mines working single entry faces and partly on cycle calculations.

The calculations consider anticipated performance with delay and operational factors incorporated to develop sustainable average rates from optimum machine operations.

5.9.1 Parameters

The following parameters were used:

Face length	25 m
Web depth	1.0 m
Height mined	2.3 m
Available time at face per shift	6.0 hrs
Density of coal	1.35 t/m^3
Shearer cutting speed	
- top coal (1.7 m coal)	8 m/min
- bottom coal (0.6 m coal)	12 m/min

5.9.2 Cycle Time

Table 5-6 gives the calculation of the expected face cycle time for a 25 m face. Face move over includes a 10 second cycle for each support (under electrohydraulic control) plus a similar total allowance for advancing the shearer and AFC.

5.9.3 Production

Based on the achievement of 15 cycles per shift (Table 5-6), the expected production rates are calculated as follows:

Production per Cycle/Strip = 25 x 2.3 x 1.0 x 1.35
= 77.6 tonnes

Output - Shift		77.6 x 14.6 = 1130 t
	- Day (3 sh)	3390 t
	- Week	17950 t
Face Retreat - Shift		14.6 m
	- Day	43.2 m
	- week	216 m

Maximum production rate

- cutting top coal, 90% loaded at 8 m/min	990 tph
- cutting bottom coal + loading 10% top coal at 12 m/min	695 tph

5.9.4 Productivity

Based on 3 shift working, with a shift crew of 6 2/3 (as per section 5.8.3) plus 1 gate belt operator, the expected district OMS is:

3390/(7.67 x 3) = 147 t/MS

and the face OMS is:

3390/(6.67 x 3) = 169 t/MS

5.10 FACE INSTALLATION, RECOVERY AND TRANSFER

The weight, dimensions and transfer distance of the various pieces of equipment, in conjunction with the transportation means determine the rate of face installation and transfer.

If the face is nearing completion then many things can be done in preparation not least of which should be the support of the roof to enable the powered supports to be removed. If the timing is right, provision could be made for adequate space in front of the supports as they advance to their final position to provide sufficient access for transport vehicles. Figure 5-41 shows the typical pre-recovery supplementary support required to enable the face equipment to be safely recovered.

The removal of the maingate conveyor and structure should be first priority as this would give free uninterrupted access for transportation vehicles. The face should terminate approximately 60 m from the main roadway. With the face equipment within easy reach of the main arterial roadway the electrical switch gear can be dismantled. Power required to move the shearer and run off the AFC chain can be done by using a utility cable.

With the switch gear and auxiliary fan off the AFC/stage loader, the dismantling of the AFC and coal sizer can commence. All equipment can be transported directly to the next face location. With the gate road clear of equipment, the shearer transporter can be positioned in line with the face, and the shearer driven under its own hauulage onto the transporter. The shearer should be stored until the pan line is complete on the new face.

The remainder of the AFC ramp pans and spill plates can then be removed. The line pans can be removed and transported in pairs. It would be good practice to have a new or reconditioned tail end available and already installed on the new face as this is a high wear item.

Hydraulic pressure would still be available from the remote pump station so the transfer of the supports can be readily undertaken. With adequate clearance the supports should be removed from the fast end first working to the main gate. This is the safest method. The support should be pulled onto the face line and if an additional web was taken then there should be adequate clearance alongside the remaining supports for the FSV. The support would be loaded onto the FSV and transported directly to the new face line for direct placement.

With the pan line and supports in the new position the shearer can be driven onto the AFC. The roller curve and gate section of the

AFC could then be installed followed by coal sizer, the fan and switches.

The time required to undertake the recovery, transfer and installation of a complete single entry face has, in the past, taken up to 2 weeks. The Gretley Mine are planning to carry out the whole operation in 3 days (over a 200 m distance). The expectation is that it should be possible in at least 2 weeks and preferably one week.

5.11 REGULATORY ASPECTS

The application of a single entry short longwall retreating system will be governed by the existing COAL MINES (CBDC) SAFETY REGULATIONS issued under the Canada Labour Code. However, it is understood that these regulations are in the course of being revised and a draft of the new requirements is currently being prepared. It is therefore recommended that, in the detailed design of a single entry system, discussions take place with Labour Canada to ensure that the system will be designed to meet the requirements of the impending new regulations.

The present regulations require the following preparatory action before a single entry system can be introduced.

- The Mine Manager has to prepare a support plan for the roadway development, the face line drivage and the retreating face including the installation and recovery of the face supports [Reg. 20(2)].

  Particular attenion should be paid to the stability of the single entry roadway, the roadhead/face entry and the blind end of the face.

- A plan for the inspection and maintenance of all electrical and mechanical equipment and devices has to be prepared [Reg. 20(1)].

  This should include all monitoring and control equipment, and take into account the unique risks inherent in the single entry mining system.

- A certified ventilation survey plan is required which has to be approved by the Chief Inspector [Reg. 31(1)].

- Ventilation plans for the development phase and the retreat mining phase showing fan locations and capacities; direction of air flows; the maximum percent of CH_4 found at each sample location; required minimum quantities of air; location of

regulators, airways, doors, stoppings; and all other information necessary to permit an accurate appraisal of the ventilation system [Reg. 73(1)]. These plans require the approval of the Chief Inspector.

The latter requirement should include the location and operational settings of all monitoring and control devices for the ventilation and environmental systems.

- Approval of the Chief Inspector is required before any auxiliary fan can be installed [Reg. 75(3)].

- The location and frequency of testing for gas shall be such as to ensure that dangerous concentrations of gas are detected in time for corrective action to be taken and to permit safe evacuation if necessary [Reg. 77(7)].

  This places particular emphasis on the need to identify the locations on the single entry retreating face where methane is most likely to enter the ventilation stream on the face.

- Permission will be required to use the single entry roadway for the transport of materials and personnel (if transport of the latter is proposed) [Reg. 84(1)].

- Support for the roof and sides of roadways or working places necessary to prevent their collapse requires approval for setting intervals and the manner of setting [Reg. 87].

  This will be particularly relevant to the support of the blind end of the face, and the roadhead/face area.

- Approval would be required to operate a diesel powered FSV [Reg. 107(1)].

- Approval is required for the use of electricity [Reg. 109].

- Approval required to permit more than 9 men to work in the single entry roadways and faces [Reg. 113(1)]. This will be particularly necessary during installation, recovery and transfer of face equipment.

- Plans of the proposed single entry mining area require the approval of the Chief Inspector [Reg. 115(c)].

- Since much of the proposed mining area has less than 150 m solid cover (but more than 60 m), soundings at least 300 m ahead of any workings are required at least once every 3 months and levels marked on the mine plans [Reg. 115(f)].

This will require a survey of the sea bed before mining can commence.

5.12 COSTS

In this type of study, only the broadest evaluation of capital and operating costs can be undertaken. Costs obtained from other operating mines in other countries are both site specific, difficult to quantify regarding what they contain, and subject in comparison to the vagaries of the exchange rates.

In these circumstances, it was decided that the best comparisons would be on a cost savings basis utilizing data provided by CBDC and the manufacturers.

5.12.1 Capital Costs

Compared with the existing system of retreat longwall mining at the Prince Mine, the following major additions and deletions in capital equipment can be expected.

Additions	Deletions
AFC roll curve section (1)	AFC Drive Unit (1)
Special goafside furnishings (30)	Line pans and furnishings (47)
90 kW fans (2)	Shields (47)
37.5 kW fan (1)	
1100 m layflat ducting	1060 m track
FSV (1)	

The order of magnitude cost of the additions and deletions are approximately $0.75 M and $3.0 M respectively, thus representing a potential capital saving of $2.25 M.

Changes in the capital costs for development do not appear to be significant, although the difference between using the VME development machine or the SERD shearer for the retreating face is of the order of $0.2 M greater for the SERDS.

5.12.2 Operating Costs

These, for the mining panels, are primarily composed of labour, materials and power costs.

Development

Manning levels, power and equipment usage in the development headings are expected to be very similar to existing development costs, with the exception of the addition of the Swellex rock bolts. Assumming 4 - 1.8 m bolts per 1.2 m of roadway, the materials additional cost would be of the order of $26,000 for the 1000 m roadway, or $0.28/t of coal produced from the panel including roadway drivage.

Retreating Face

Power costs ($/t) can be expected to remain approximately the same since the addition of the ventilating fans will be balanced by the elimination of the stage loader/motor.

Materials cost can also be expected to remain essentially constant on a $/t basis.

Labour costs can be expected to decrease, since the number of shift per week for the 'district' is approximately 285 for the #6W longwall face and 100 for the single entry face for comparable categories.

Assuming an average cost per worker per shift, (including burdens but excluding bonus,) of $170, this represents a 'district' savings of $32,000 per week, and a reduction in the labour cost per tonne of $0.70/t from $1.80/t to $1.10/t. ($630,000 per year).

5.12.3 Summary

Taking into account the increased roadway support costs, the potential benefit from the application of the single entry system at the production and manning levels proposed is a potential capital cost saving of $2.25 M per face, and a savings of the order of $0.42/tonne mined in operating costs. This comprises:

	$/t
Savings in labour cost	0.70
Additional cost of rock bolts	(0.28)
Savings	0.42

5.13 FUTURE APPLICATIONS AT OTHER CBDC MINES

As has been stated earlier in this part of the report, the single entry short longwall system is not, at present, considered to be applicable to the identified locations at the Lingan and Phalen

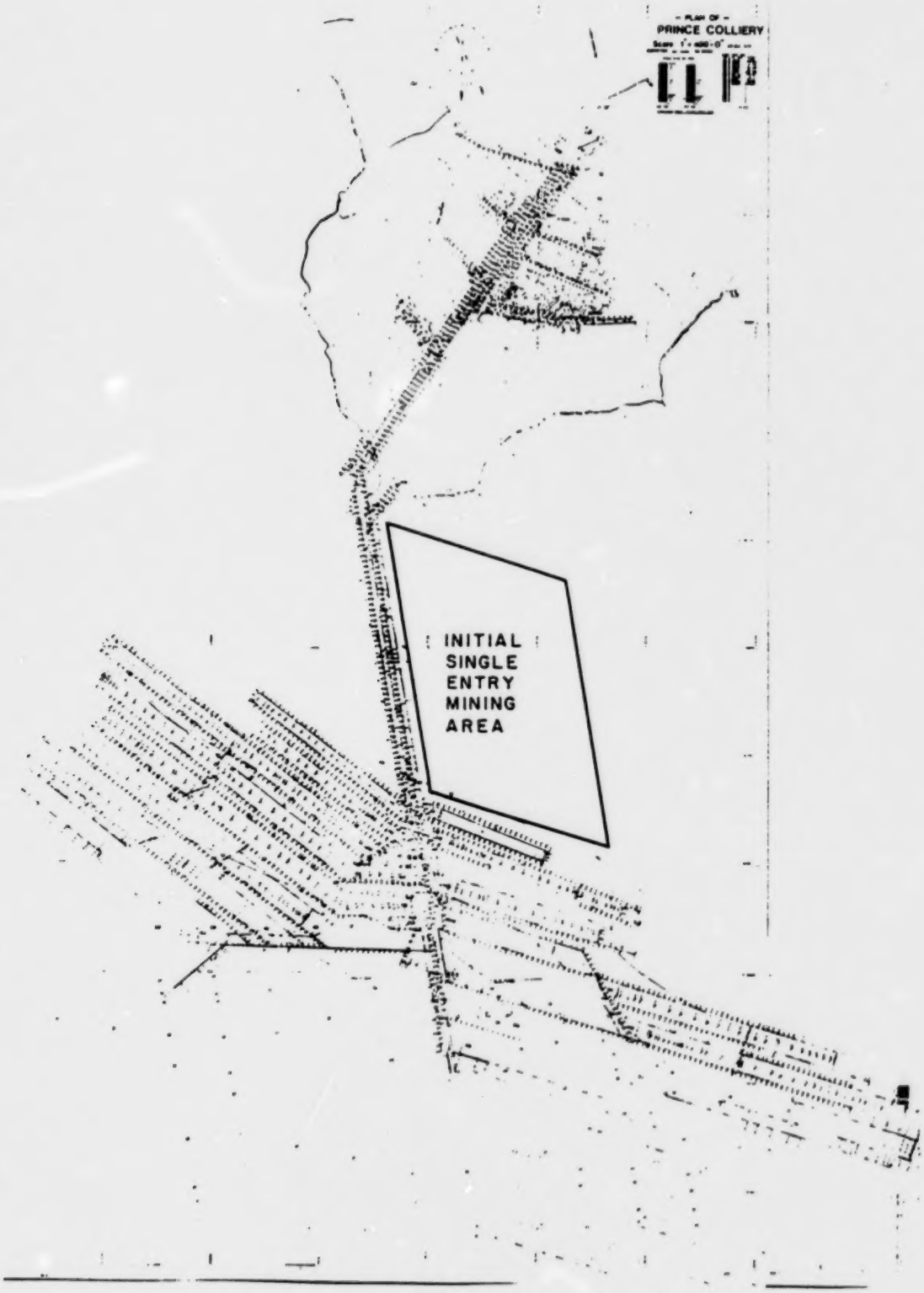
Mines. This is primarily because the levels of methane emissions at these mines are considerably higher than those experienced at mines which are operating, or have operated the single entry system.

It is considered vital that experience be gained at methane emission levels which are no greater and most likely less than has been experienced elsewhere. For this reason, the Prince Mine is the most suitable location to try the system.

The same philosophy would also apply should the Donkin-Morien Development become available for coal production. The expected level of methane emissions at Donkin-Morien are predicted to be less than those at Lingan, but still considerably more than those at Prince.

5.14 SUMMARY SPECIFICATION

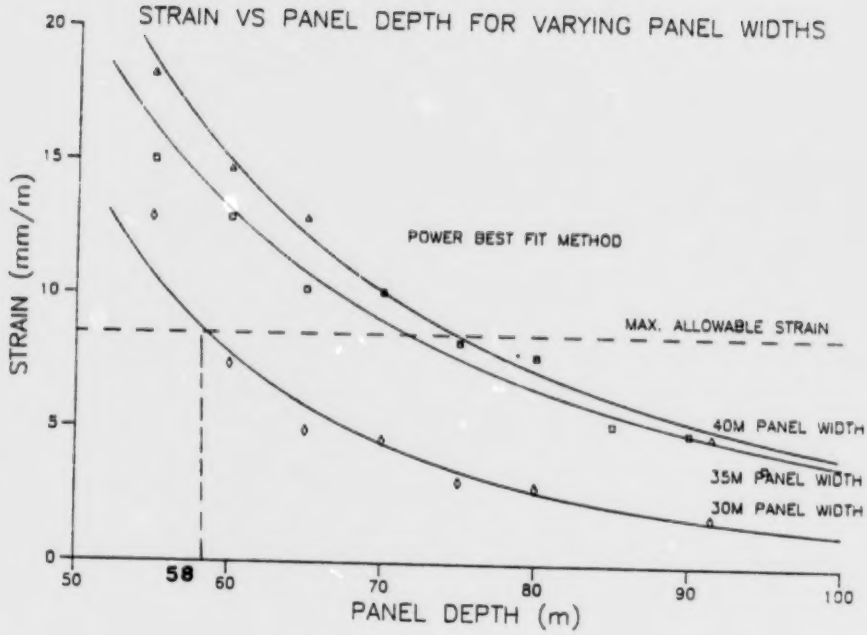
Table 5-7 summarizes the specifications of the criteria and equipment recommended for use in the single entry short longwall retreating system at the Prince Mine.

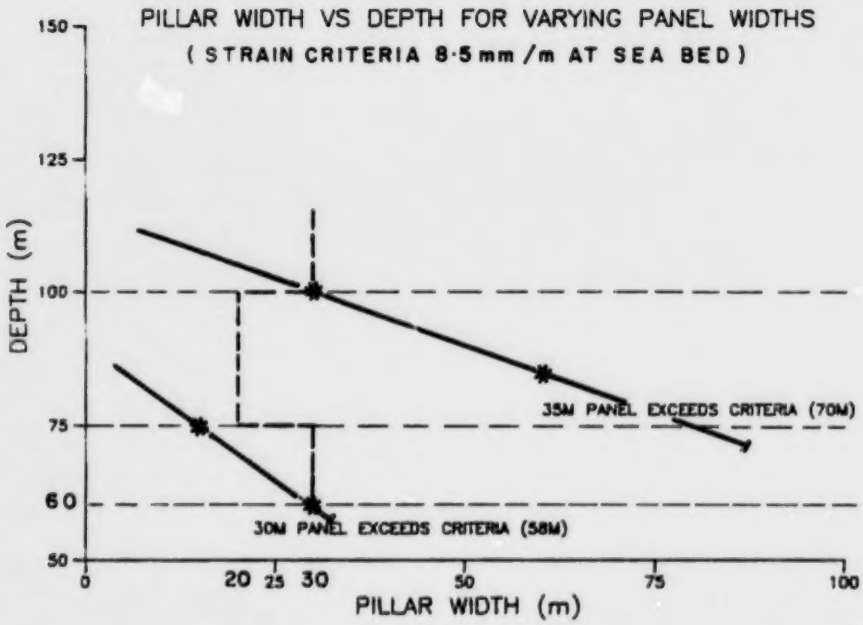


SELECTED SINGLE ENTRY MINING AREA - PRINCE MINE

(Source: Monenco)

FIGURE 5-1

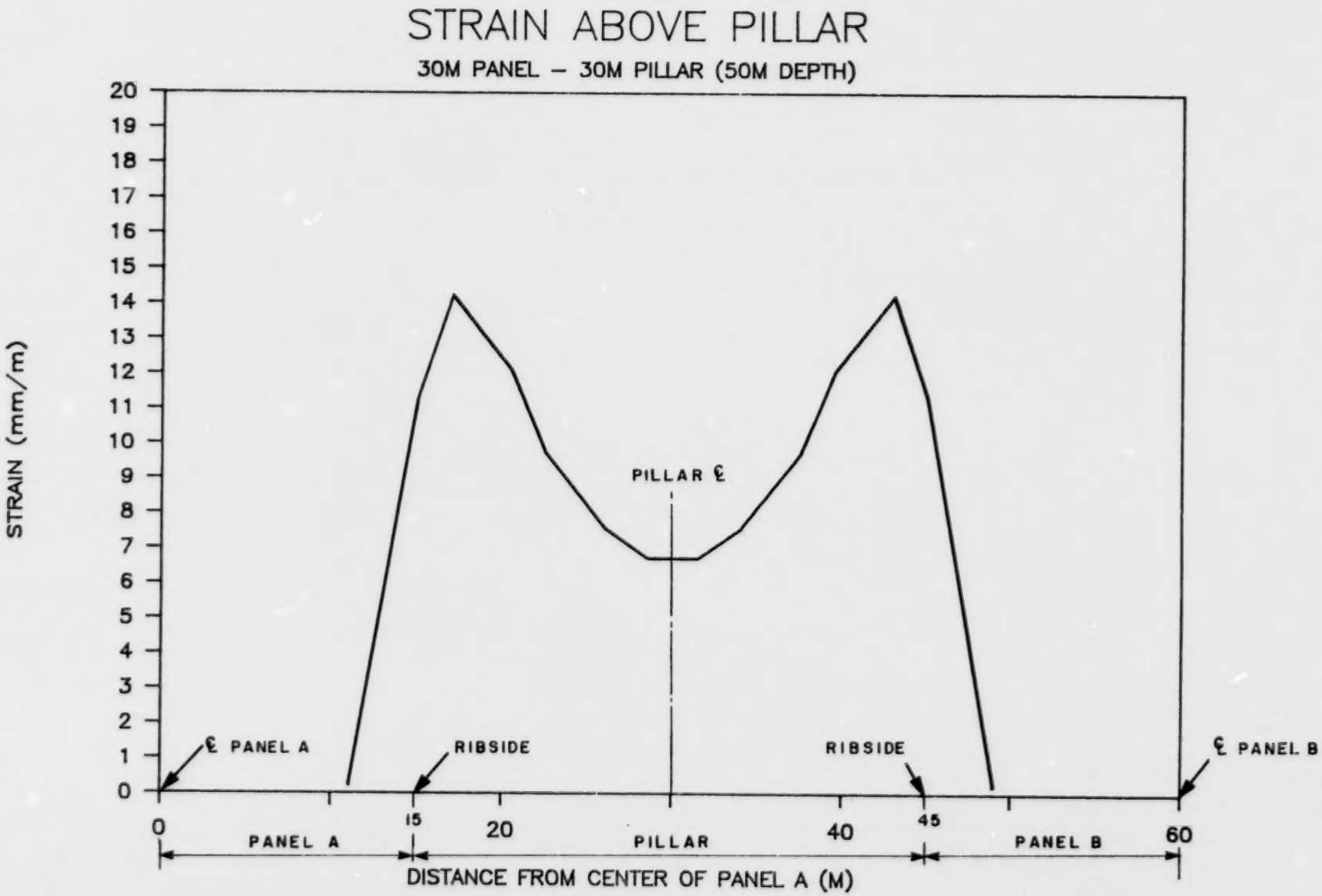




RELATIONSHIPS BETWEEN PANEL DEPTH, WIDTH PILLAR WIDTH AND STRAIN

FIGURE 5-2

(Source: Golder)

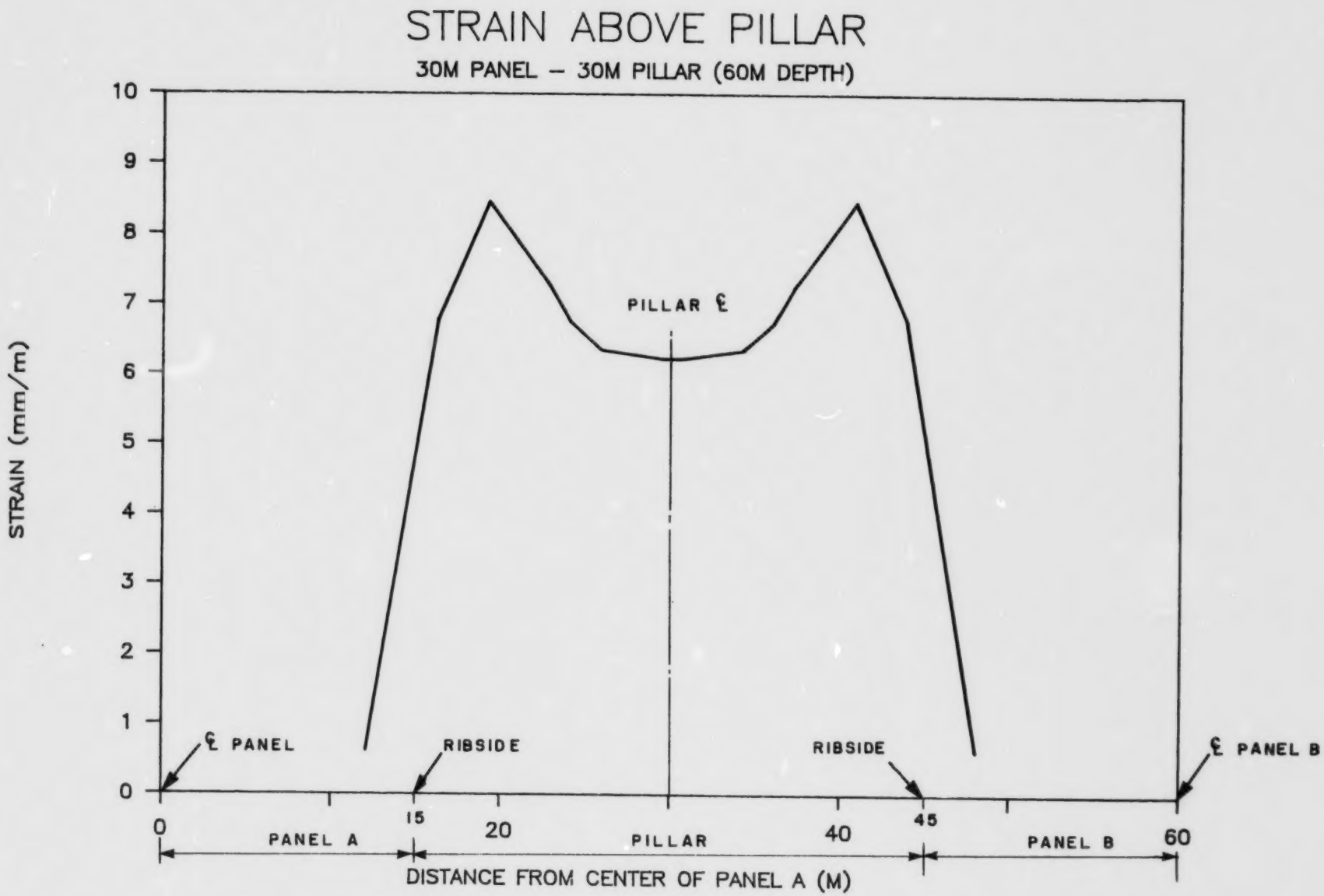


STRAIN ABOVE PILLAR - 30m PANEL, 30m PILLAR, 50m DEPTH

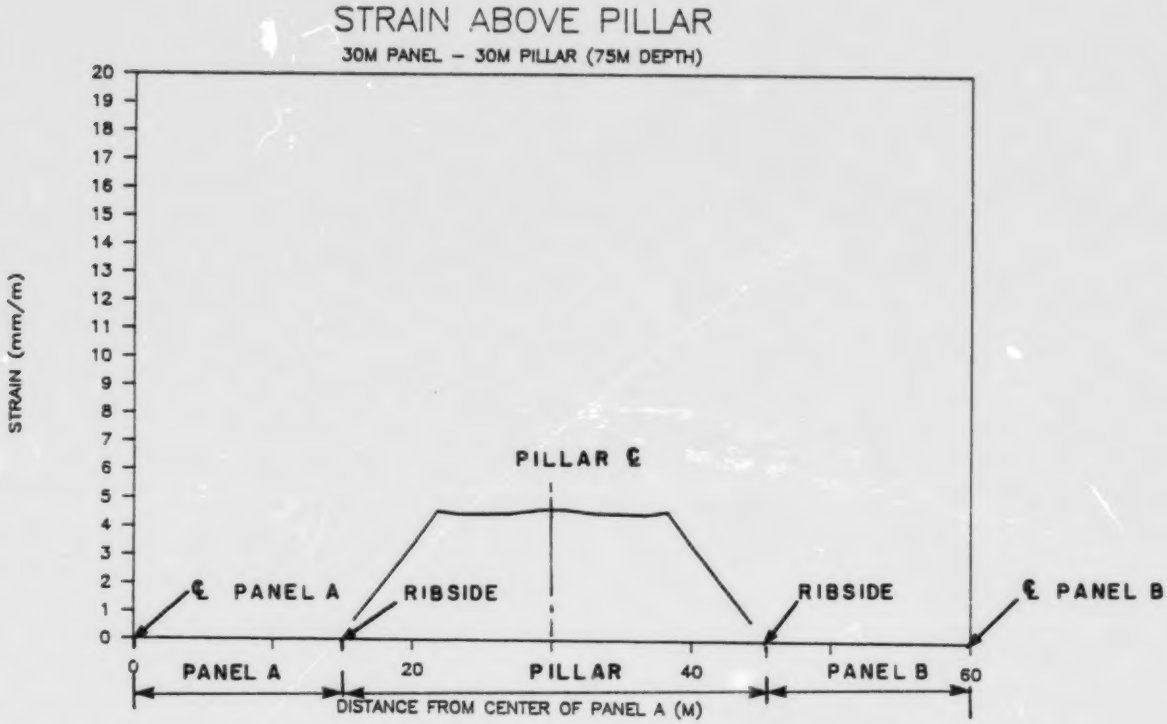
(Source: Golder)

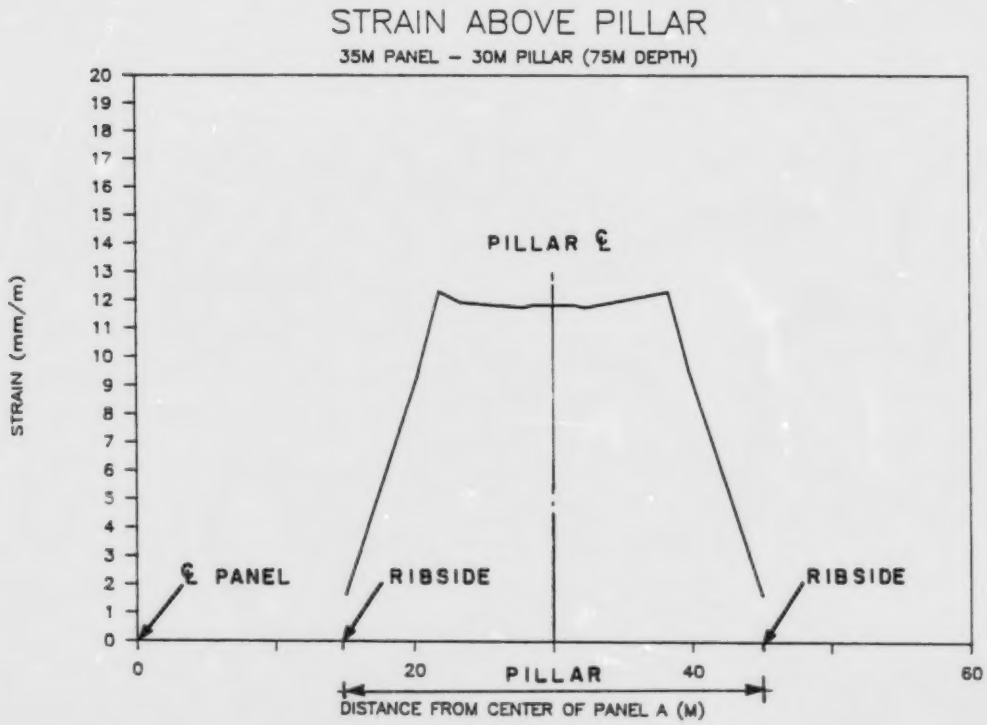
FIGURE 5-3

FIGURE 5-4



STRIAN ABOVE PILLAR - 30m PANEL, 30m PILLAR, 60m DEPTH (Source: Golder)

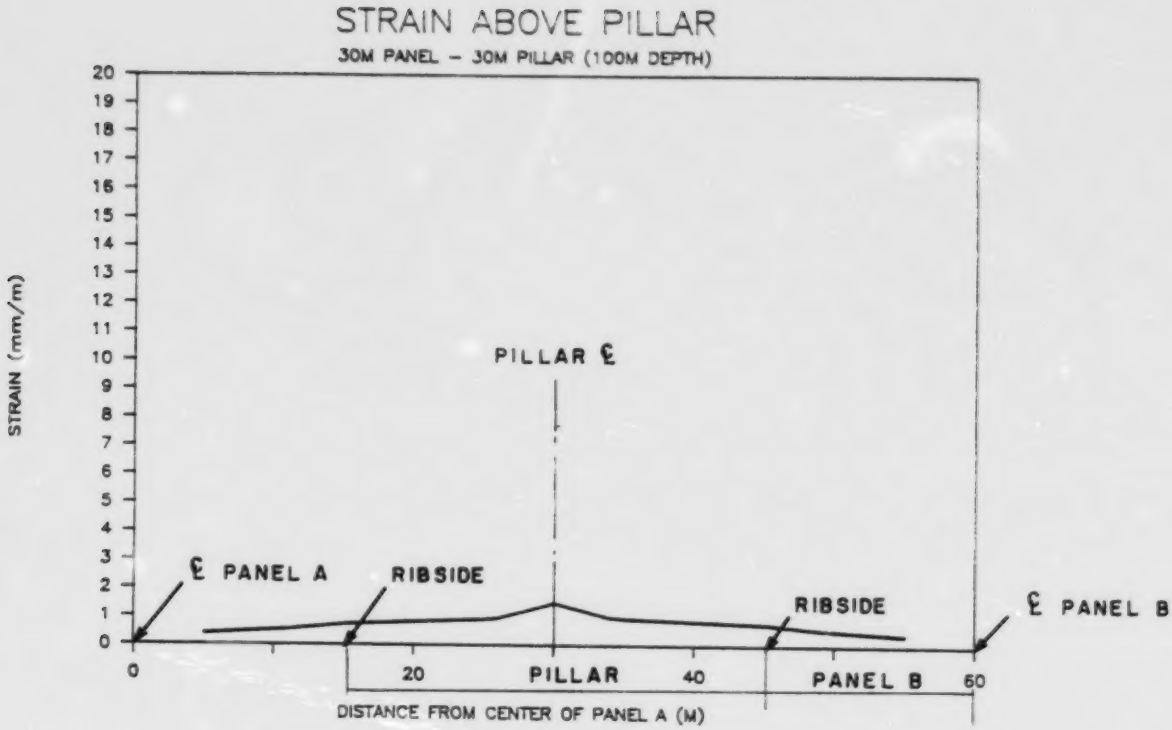


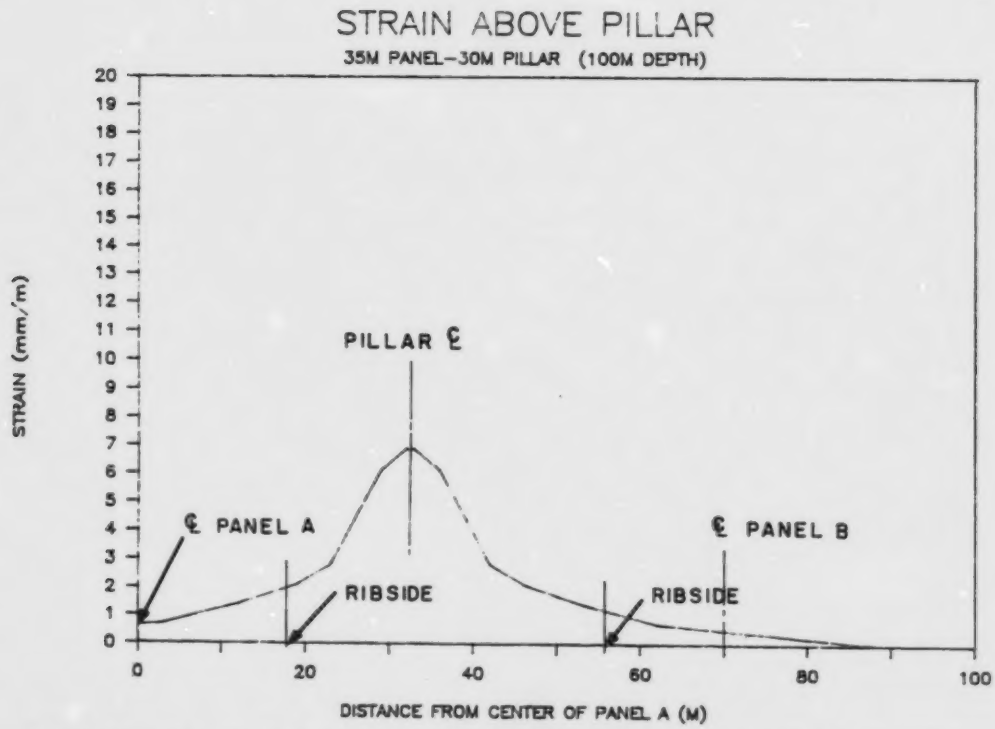


STRAIN ABOVE PILLAR - 30m PANEL, 30m PILLAR, 75m DEPTH
35m PANEL 30 m PILLAR, 75m DEPTH

(Source: Golder)

FIGURE 5-5

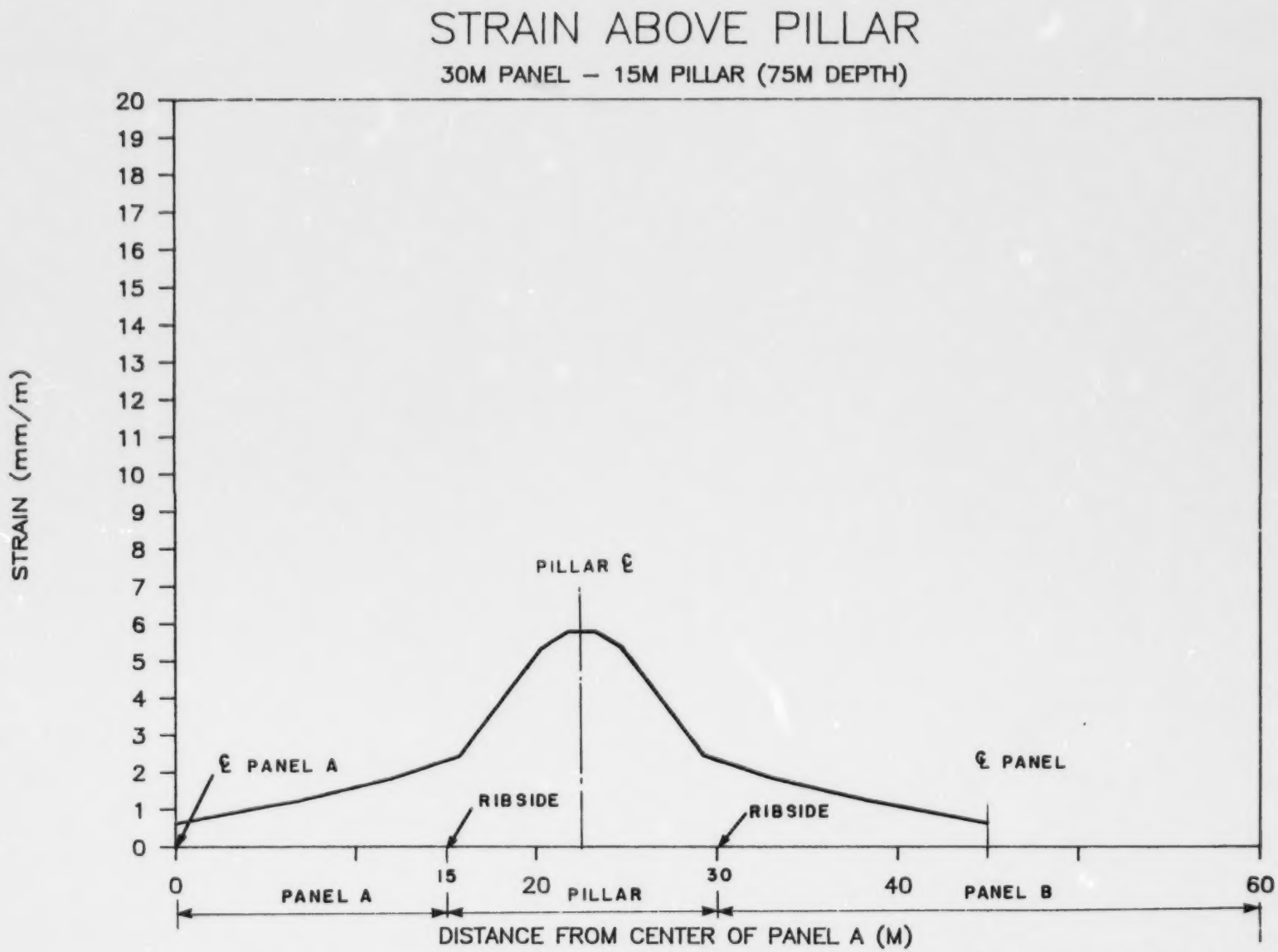




STRAIN ABOVE PILLAR - 30m PANEL, 30m PILLAR 100m DEPTH
35m PANEL 30m PILLAR 100m DEPTH

FIGURE 5-6

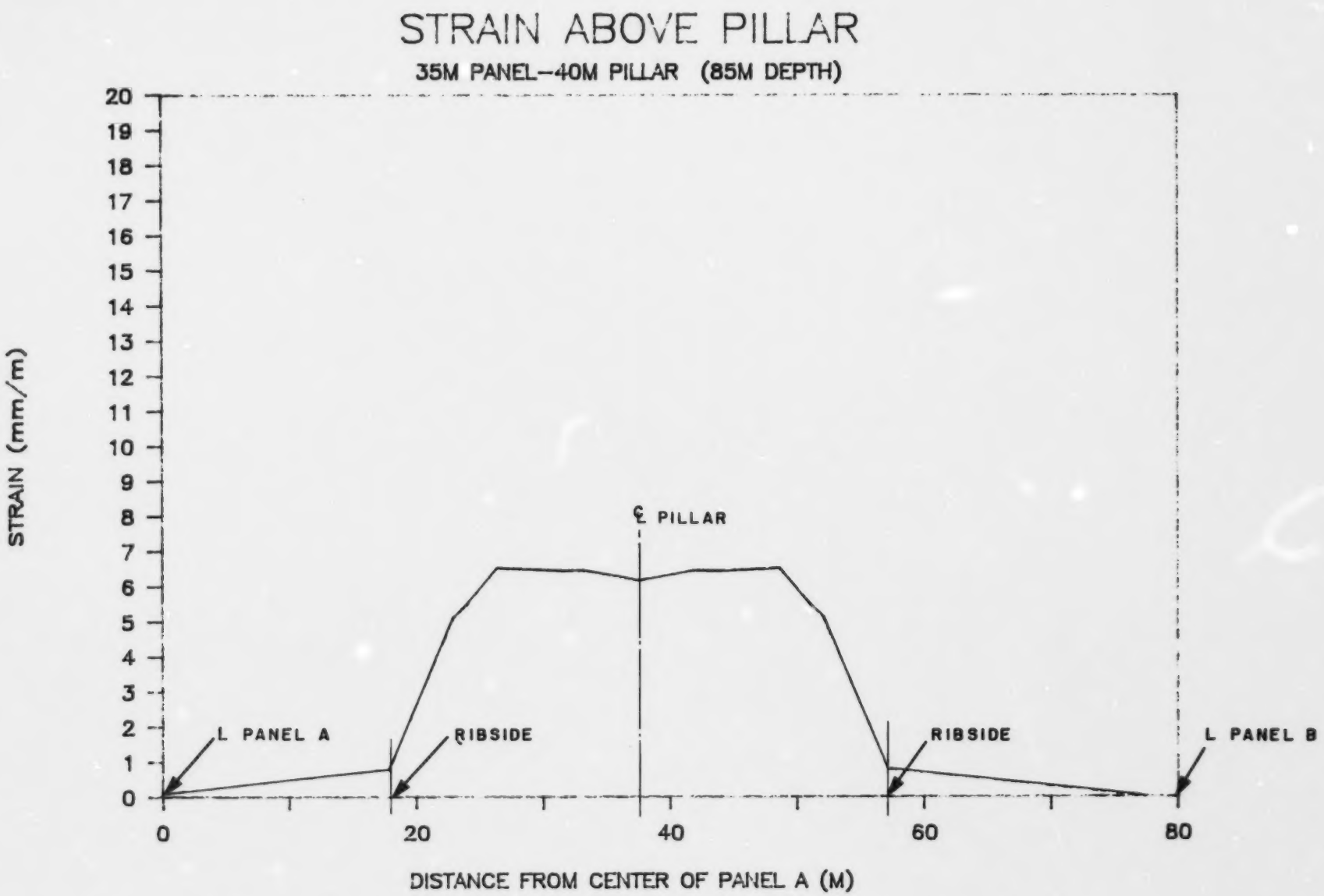
(Source: Golder)



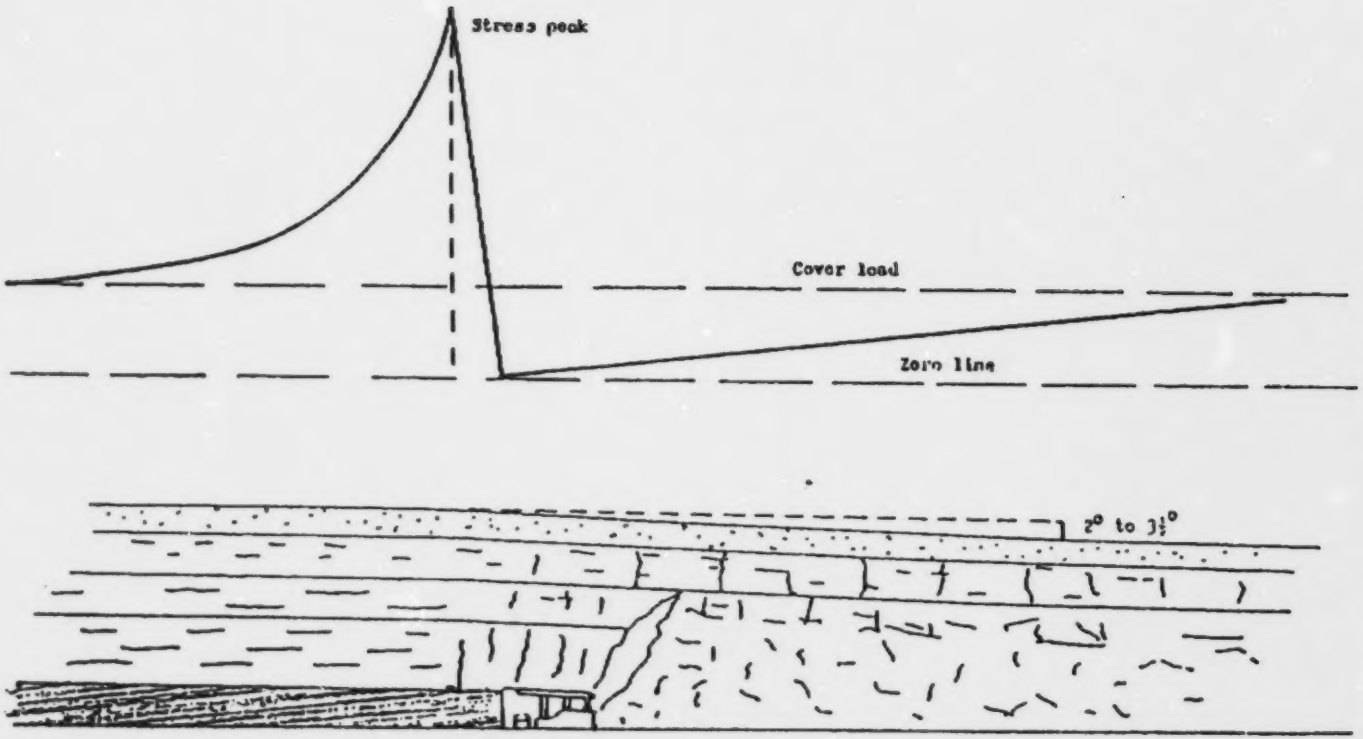
STRAIN ABOVE PILLAR - 30m PANEL, 15m PILLAR, 75m DEPTH (Source: Golder)

FIGURE 5-7

FIGURE 5-8



STRAIN ABOVE PILLAR - 35 m PANEL, 40m PILLAR, 85 m DEPTH (Source: Golder)

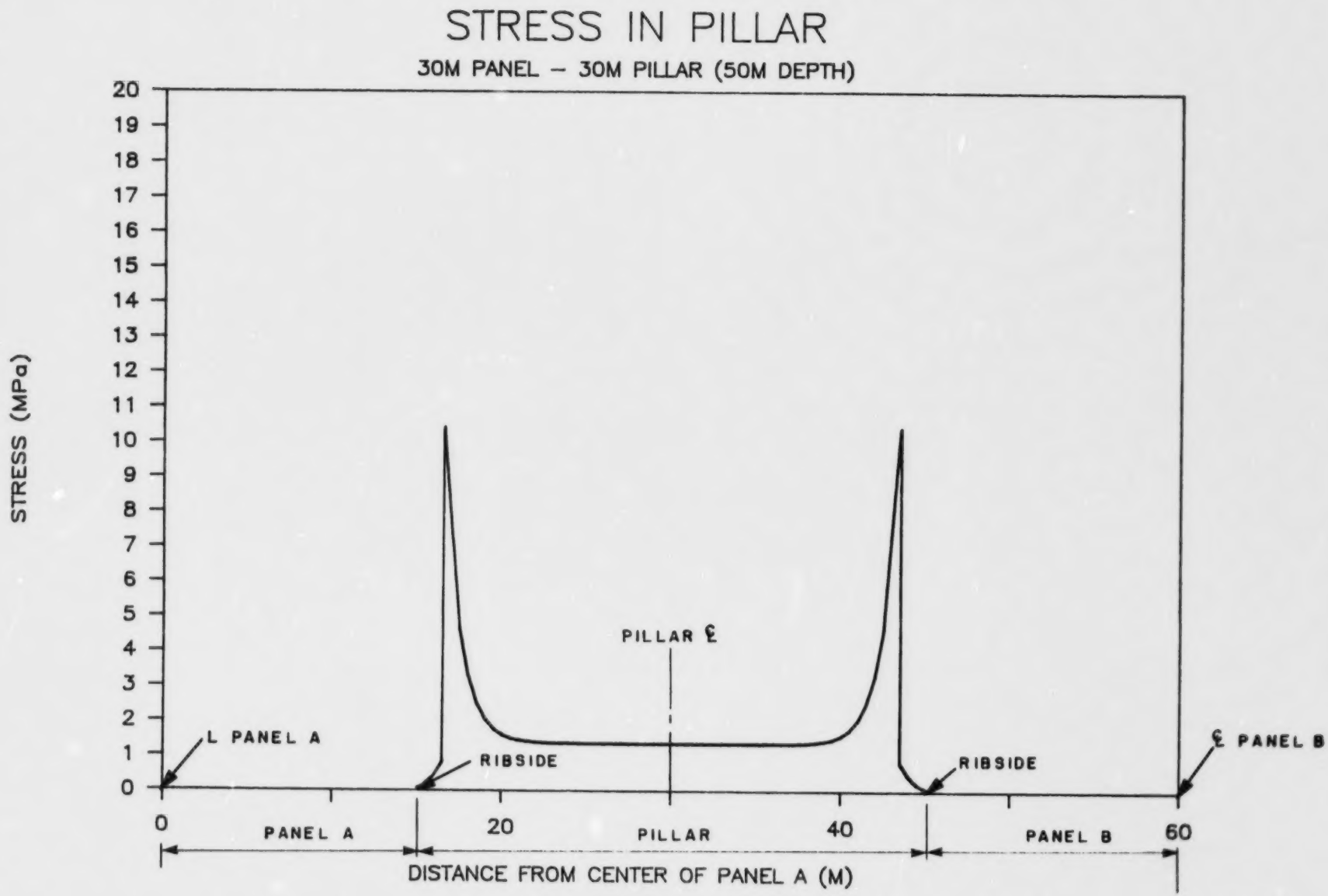


CROSS-SECTION OF TYPICAL LONGWALL FACE SHOWING

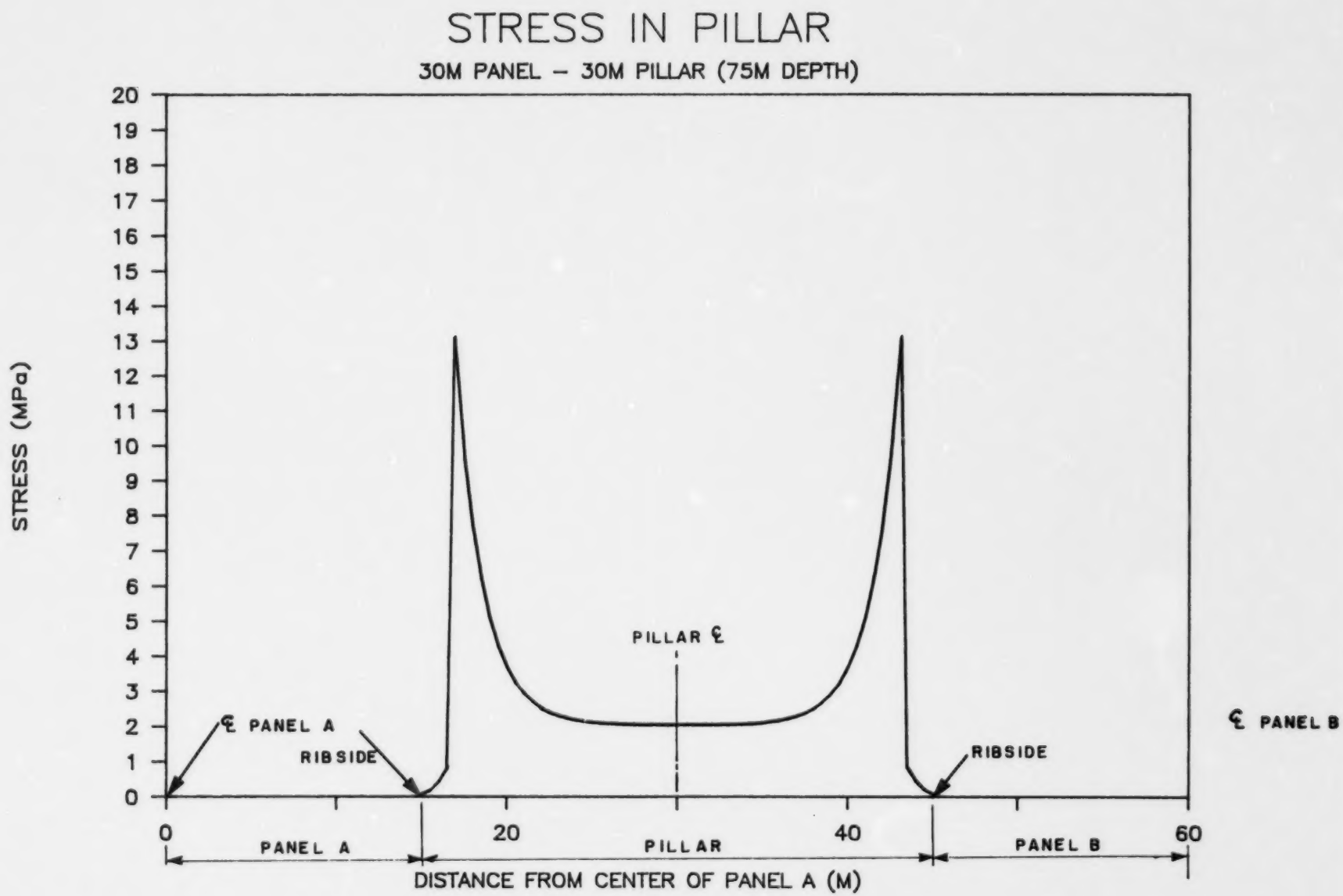
CROSS SECTION OF TYPICAL LONGWALL FACE SHOWING ASSUMED DISTRIBUTION OF VERTICAL STRESS (Source: Ref.B10)

FIGURE 5-9

FIGURE 5-10



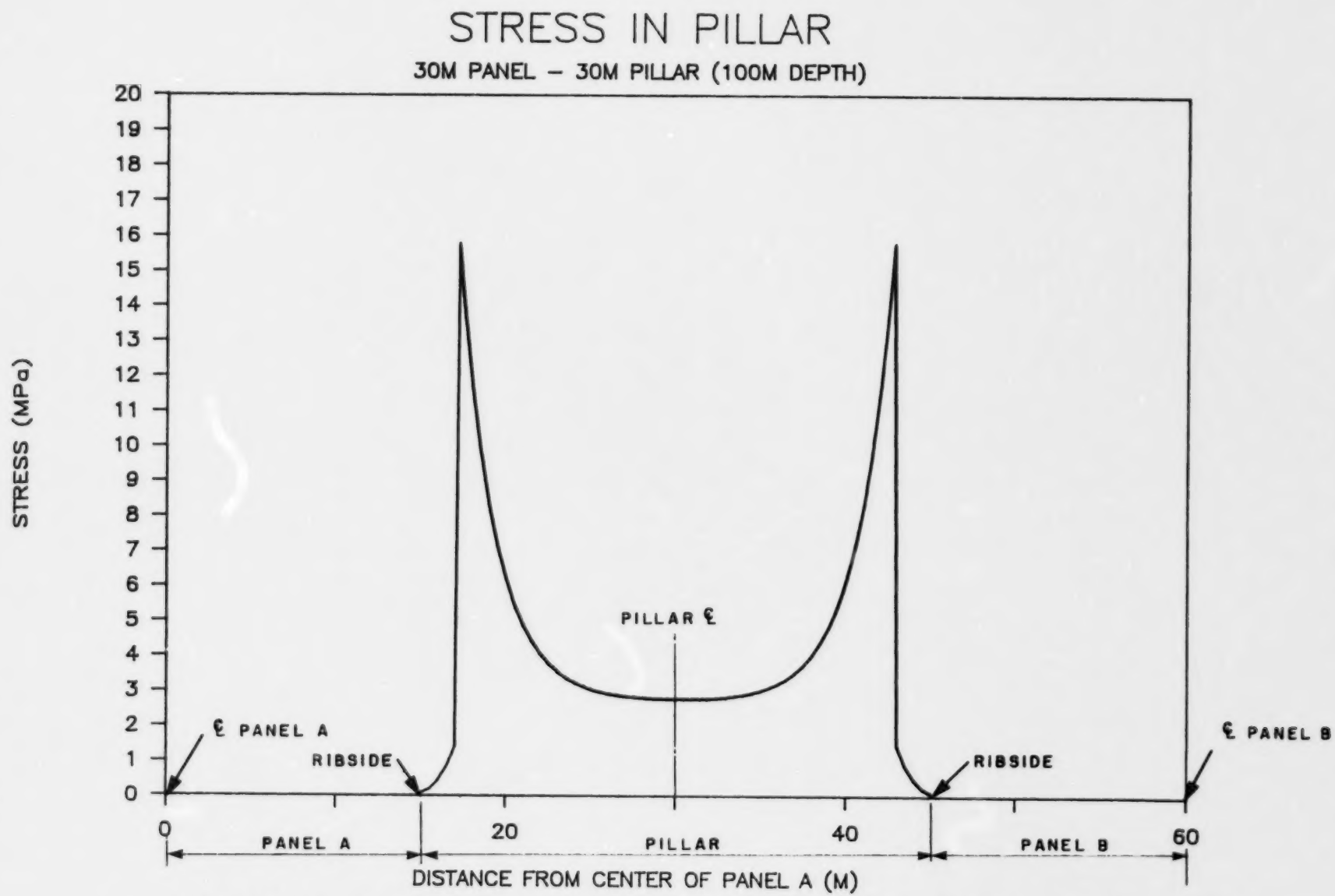
STRESS IN PILLAR - 30 m PANEL, 30 m PILLAR, 50 m DEPTH (Source: Golder)



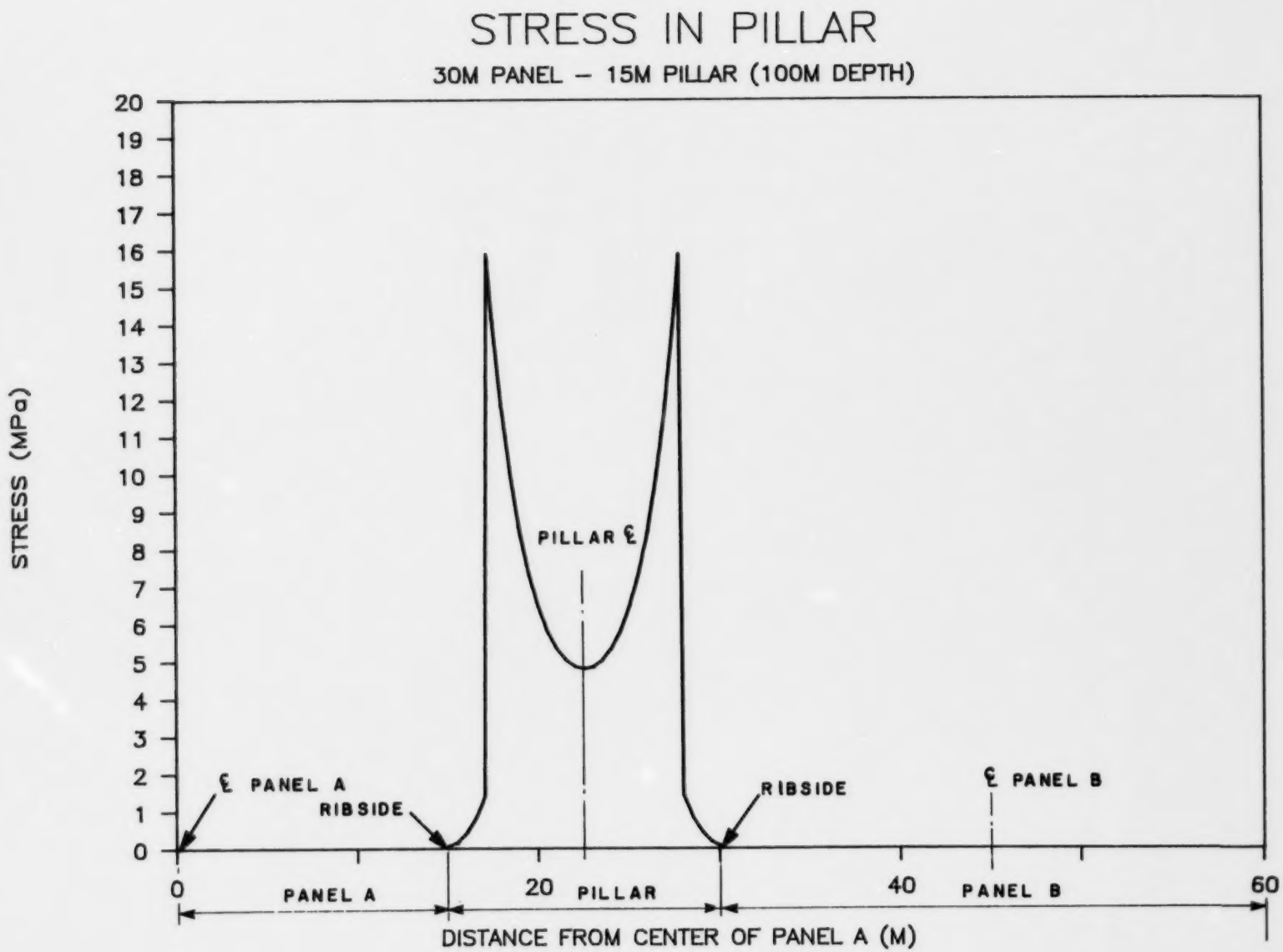
STRESS IN PILLAR - 30 m PANEL, 30 m PILLAR, 75 m DEPTH (Source: Golder)

FIGURE 5-11

FIGURE 5-12



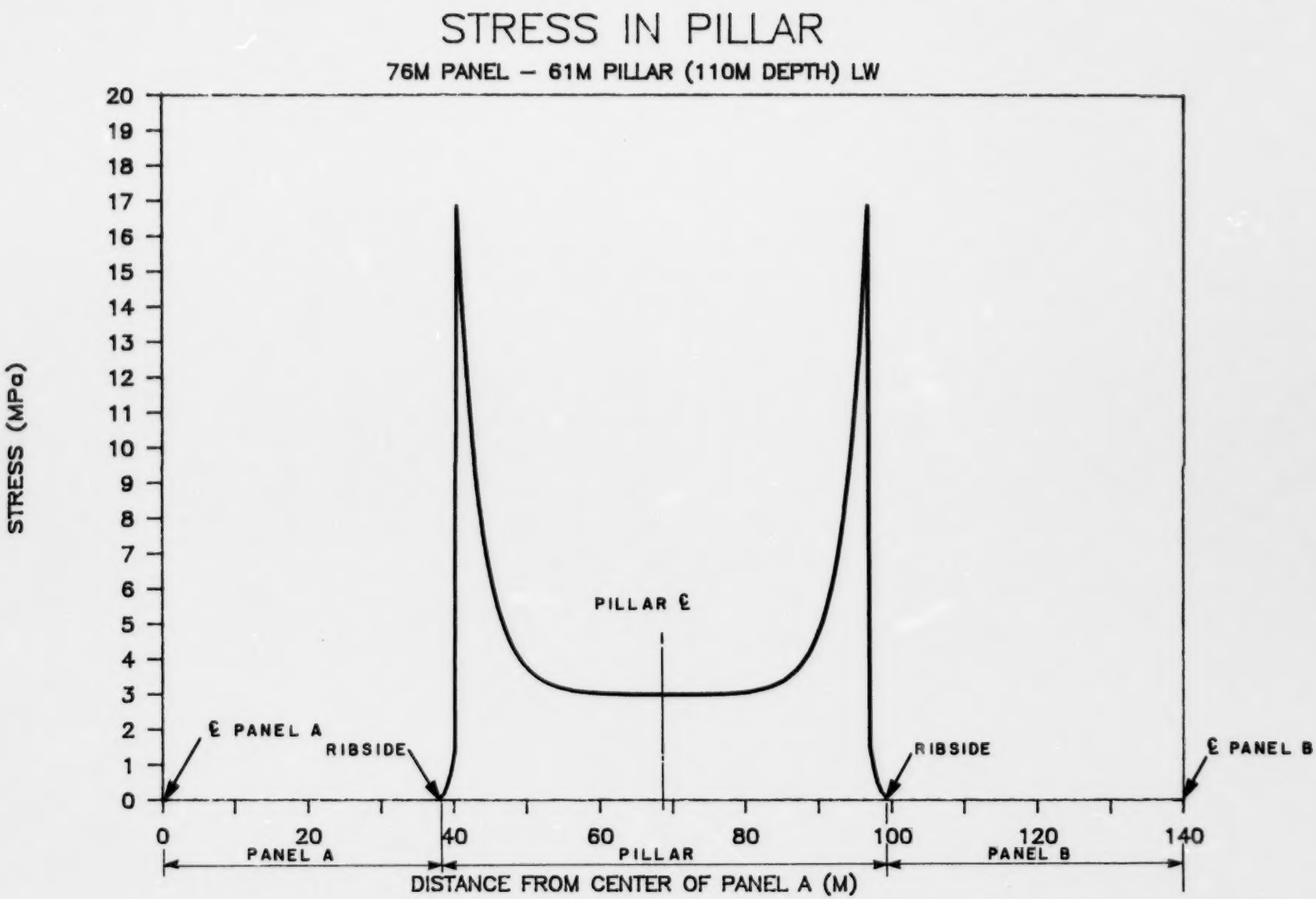
STRESS IN PILLAR – 30 m PANEL, 30 m PILLAR, 100 m DEPTH (Source: Golder)



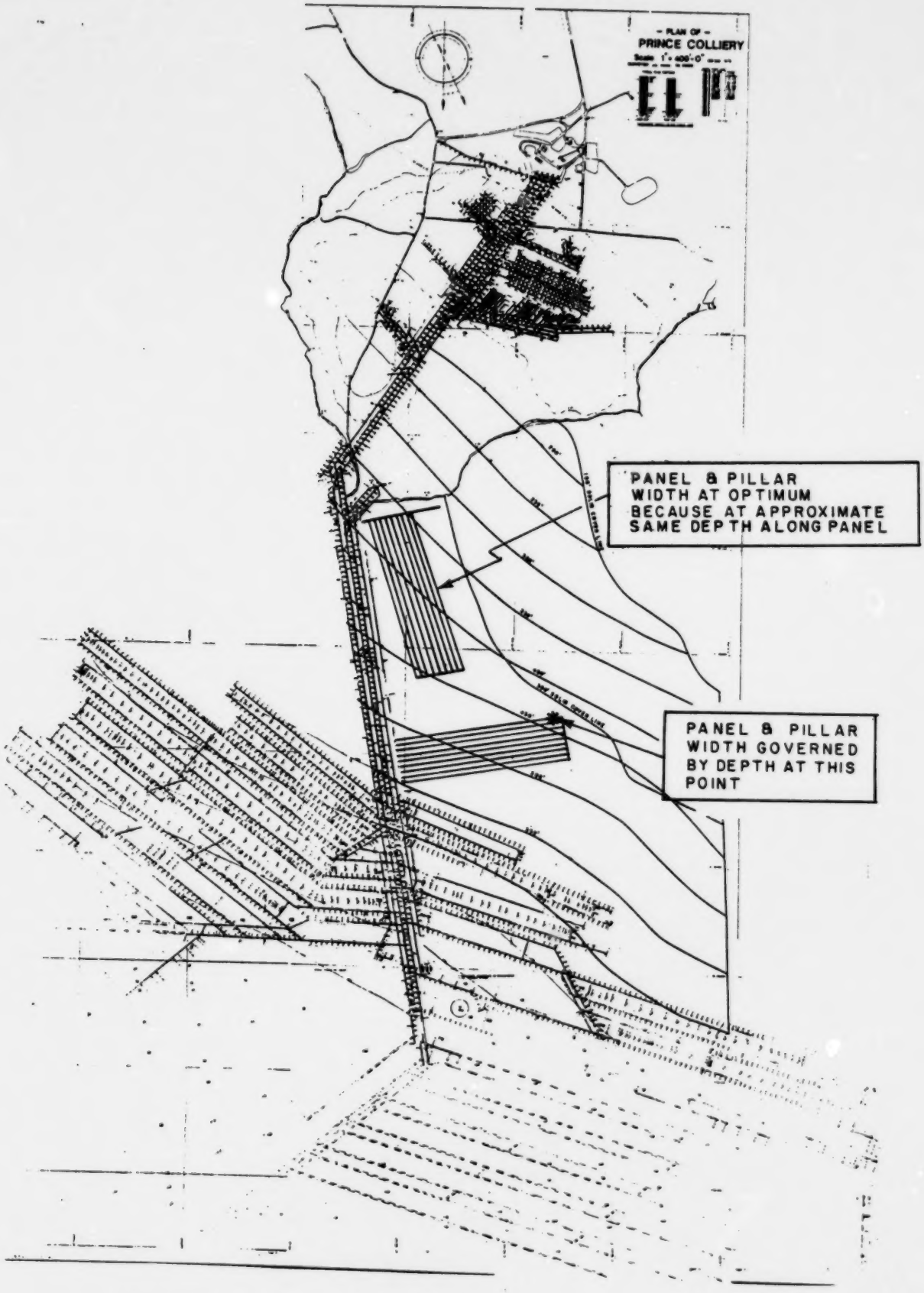
STRESS IN PILLAR - 30 m PANEL, 15 m PILLAR, 100 m DEPTH (Source: Golder)

FIGURE 5-13

FIGURE 5-14



STRESS IN PILLAR - 76 m PANEL, 61 m PILLAR, 110 m DEPTH (Source: Golder)



POSSIBLE PANEL LAYOUTS

(Source: Monenco)

FIGURE 5-15

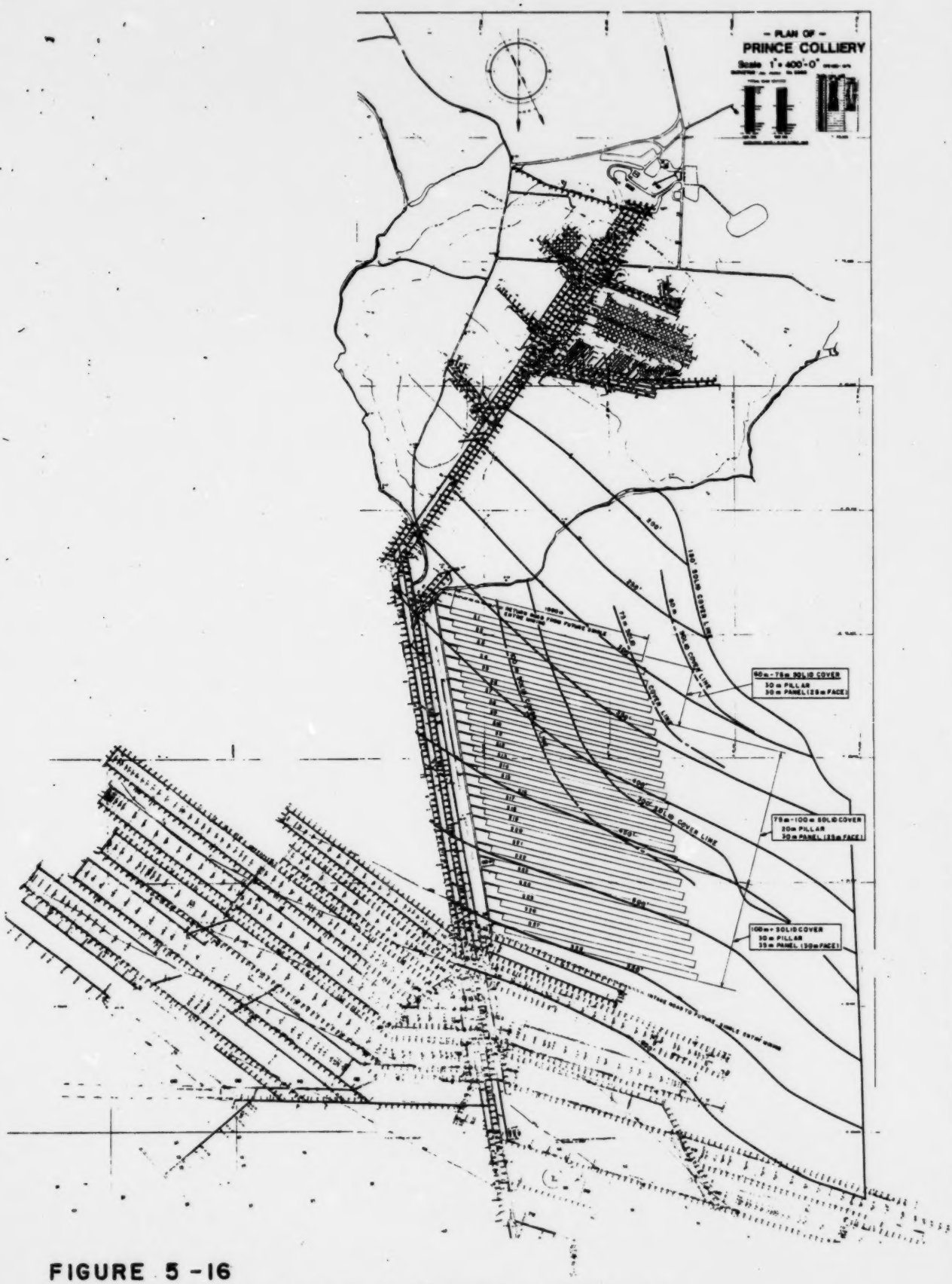
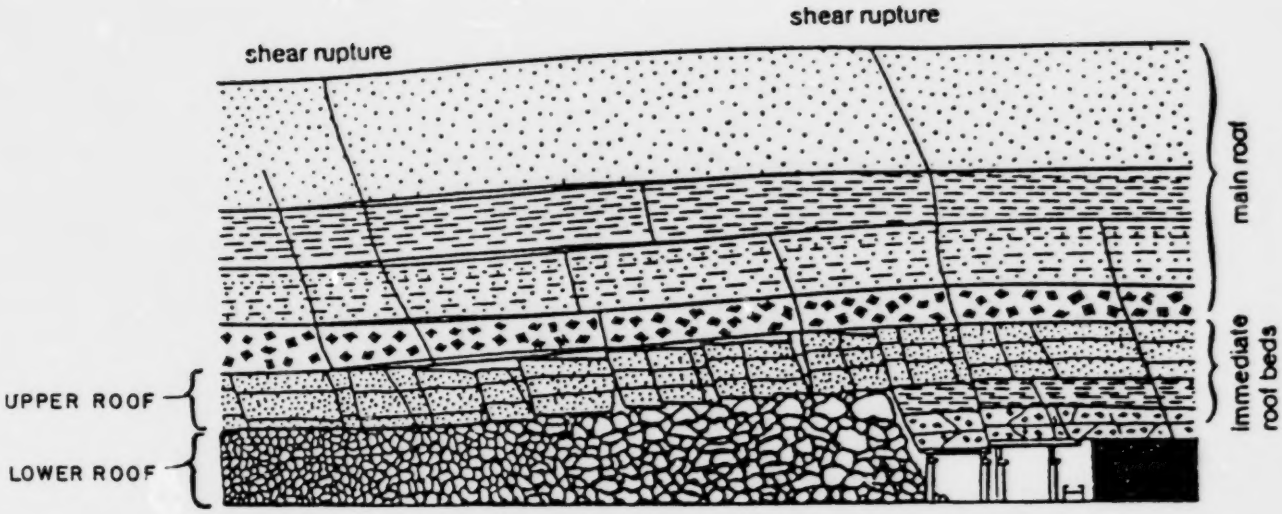


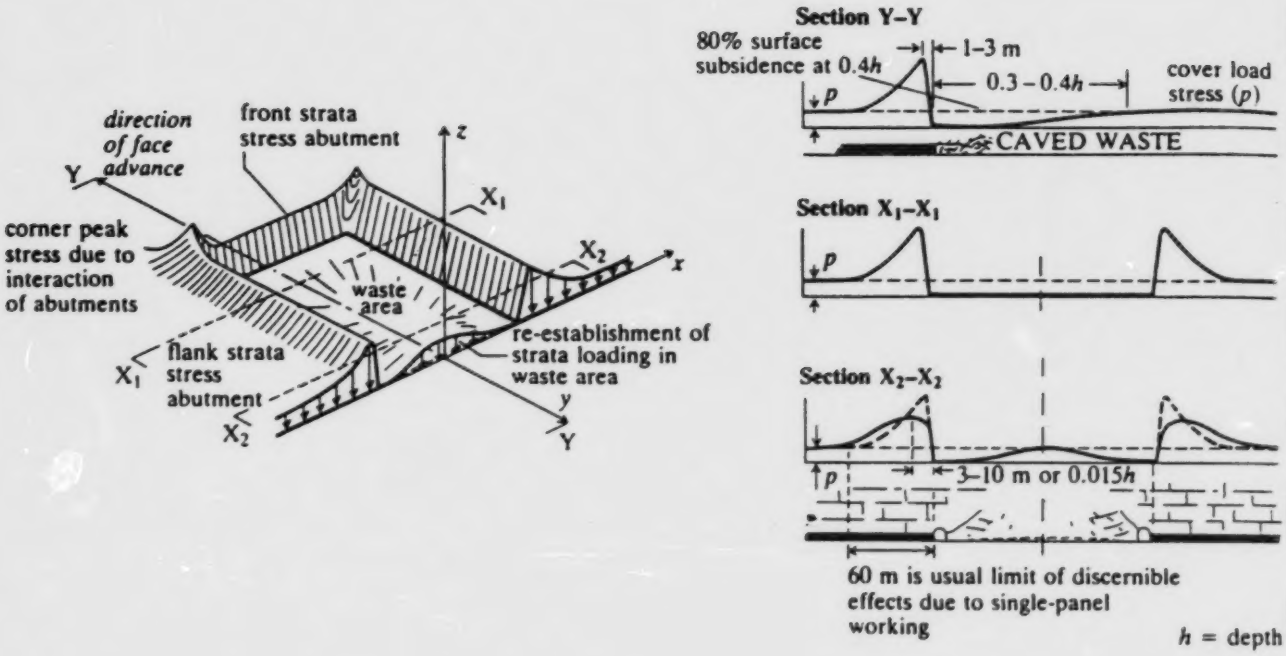
FIGURE 5 -16
SINGLE ENTRY MINING PROPOSED LAYOUT OF INITAL MINING AREA (Source: Monenco)



CROSS - SECTION THROUGH TYPICAL LONGWALL FACE

(Source: Ref.B10)

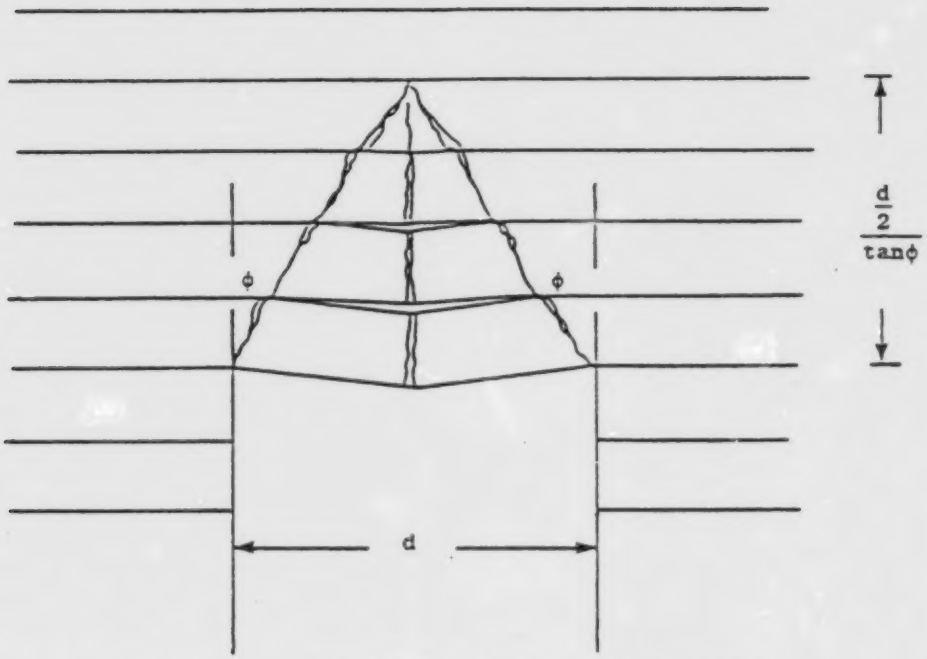
FIGURE 5-17



STRESS DISTRIBUTION OVER TOTAL EXTRACTION PANEL

FIGURE 5-18

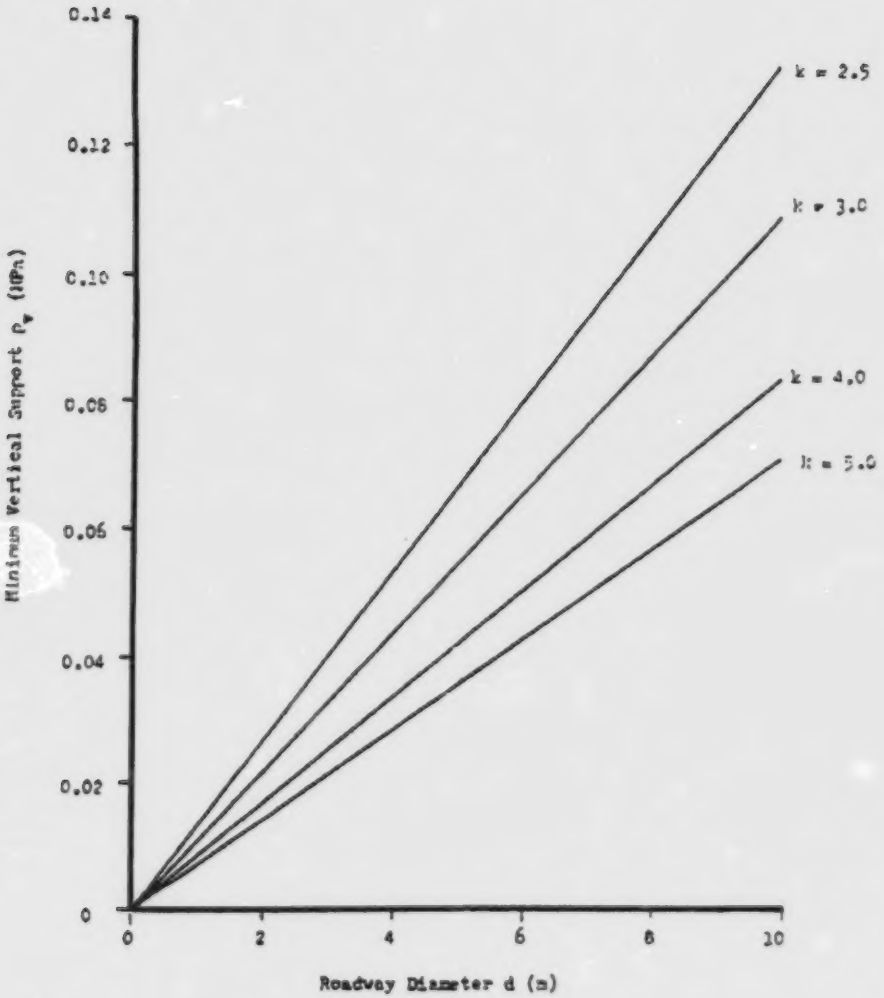
(Source: Ref.B10)



POSSIBLE AREA OF BROCKEN GROUND ABOVE ROADWAY IN STRATIFIED ROCK

(Source: Ref.B7)

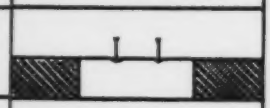
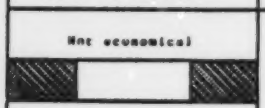
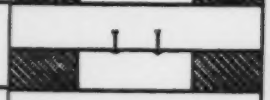
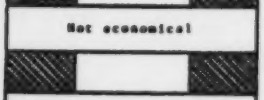
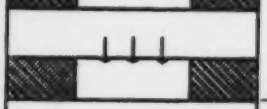
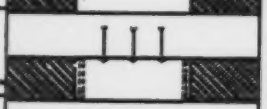
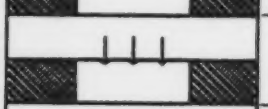
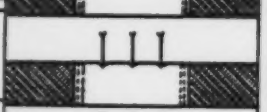
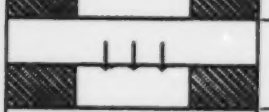
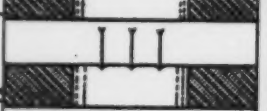
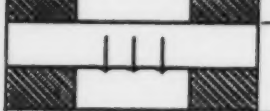
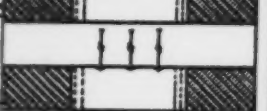
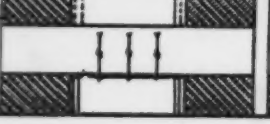
FIGURE 5-19



VERTICAL SUPPORT RESISTANCE IN A ROADWAY

FIGURE 5-20

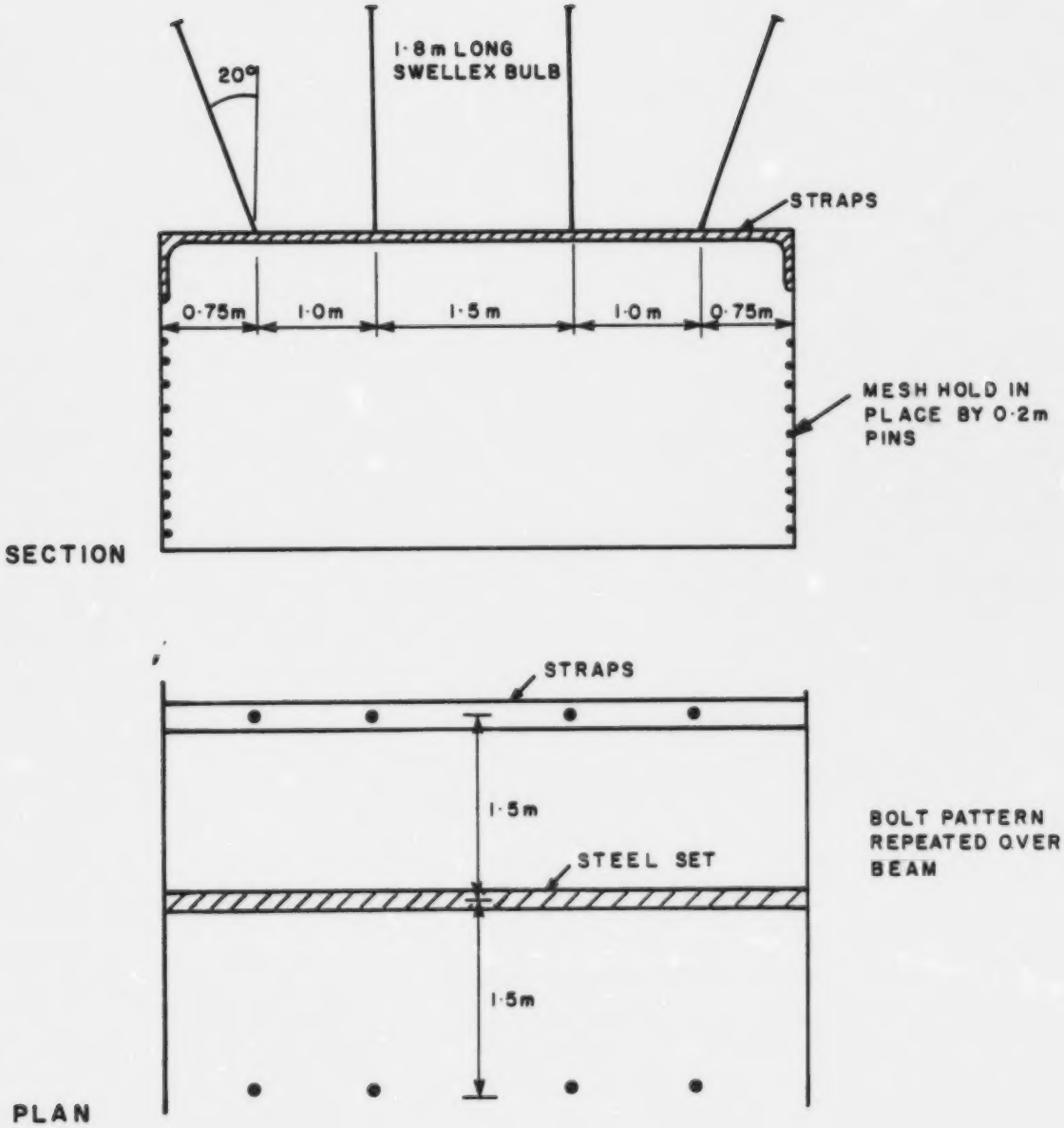
(Source: Ref.B10)

ROCK CLASS	ROCK MASS RATING (RMR)	ROCK LOAD HEIGHT (RMR/FT)	SUPPORT SPECIFICATIONS		ALTERNATE SUPPORT - PATTERNS		SPECIFICATIONS FOR POSTS
			MECHANICAL BOLTS	RESIN BOLTS	MECHANICAL BOLTS/POSTS	RESIN BOLTS/POSTS	
I VERY GOOD	90	1.6	L : 2.5' S : 4' x 5' G : 40 φ : 5/8" C : 6.2 tons			Not economical 	
	80	3.2	L[1]: 2.5' S[2]: 4' x 5' G : 40 (40) φ : 3/4" C : 11 tons			Not economical 	
II GOOD	70	4.8	L : 3.0' S : 4' x 4.5' G : 40 (40) φ : 3/4" C : 10 tons	L : 2.5' S : 4' x 5' G : 40 φ : 3/4" C : 12 tons			
	60	6.4	L : 4.0' S : 4' x 5' G : 40 φ : 5/8" C : 9 tons	L : 3.0' S : 4' x 5' G : 40 φ : 1" C : 15.8 tons			ϕ_p = 4.0" S_p = 10'
III FAIR	50	8.0	L : 4.0' S : 4' x 5' G : 40 φ : 3/4" C : 8 tons	L : 3.0' S : 4' x 4.5' G : 40 φ : 1" C : 18 tons			ϕ_p = 5.0" S_p = 10'
	40	9.6	L : 5.0' S : 4' x 5' G : 40 φ : 3/4" C : 7 tons	L : 4.0' S : 4' x 5' G : 40 φ : 1" C : 23.7 tons			ϕ_p = 5.5" S_p = 10'
IV POOR	30	11.2	L : 6.0' S : 4' x 5' G : 40 φ : 5/8" C : 6 tons	L : 4.0' S : 4' x 4.5' G : 40 φ : 1" C : 23.7 tons			ϕ_p = 4.5" S_p = 5'
	20	12.8	L : 7.0' S : 4' x 5' G : 40 φ : 5/8" C : 5 tons	L : 4.0' S : 4' x 4' G : 40 φ : 1" C : 23.7 tons			ϕ_p = 5.0" S_p = 5'

ROOF SUPPORT DESIGN CHART FOR COAL MINING
5m ENTRY WIDTH

(Source: Ref.B9)

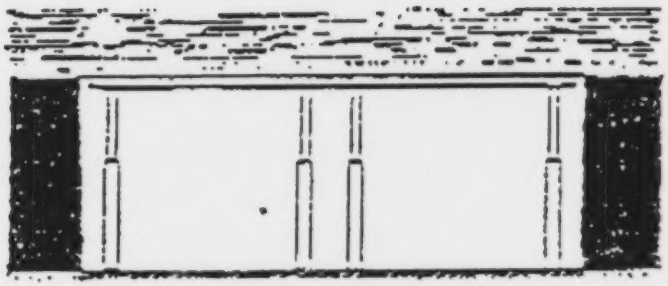
FIGURE 5 - 21



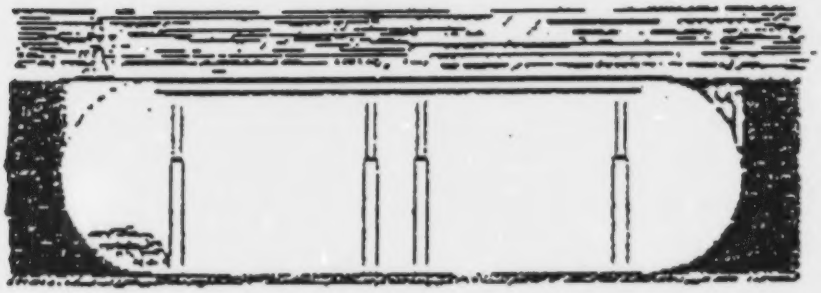
ROADWAY SUPPORT INCLUDING ROCK BOLTS

FIGURE 5-22

(Source: Golder)



WESTFALIA VME



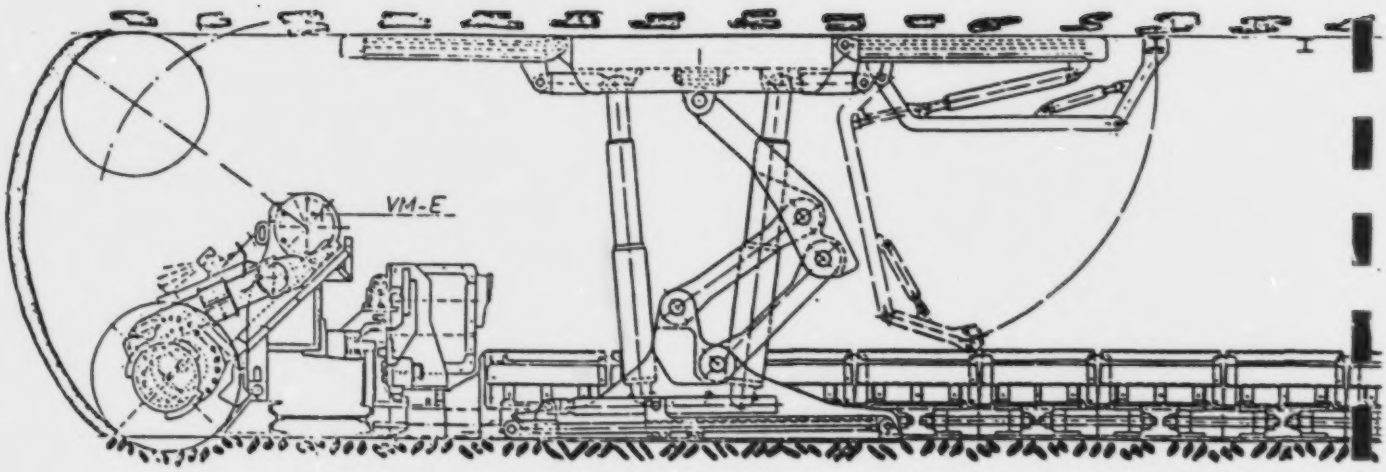
EICKHOFF ESA 150L
DOSCO ISM 2000

COMPARSION OF ROADSIDE CUT PROFILES

ROADWAY SECTION CUT BY VME, ESA & ISM

(Source: Ref.C5)

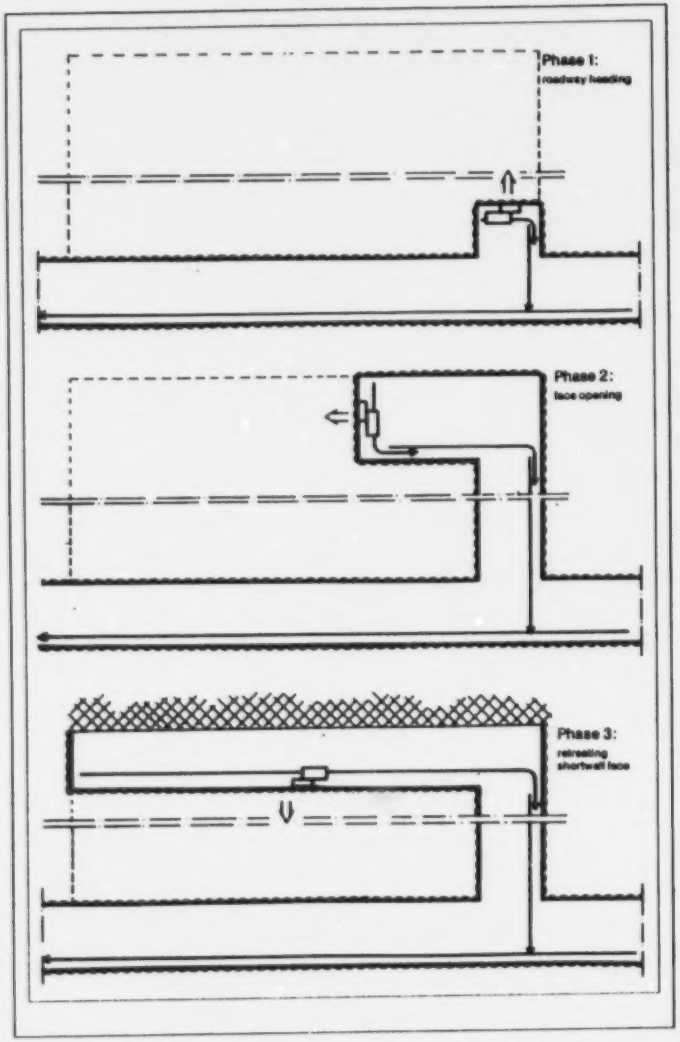
FIGURE 5-23

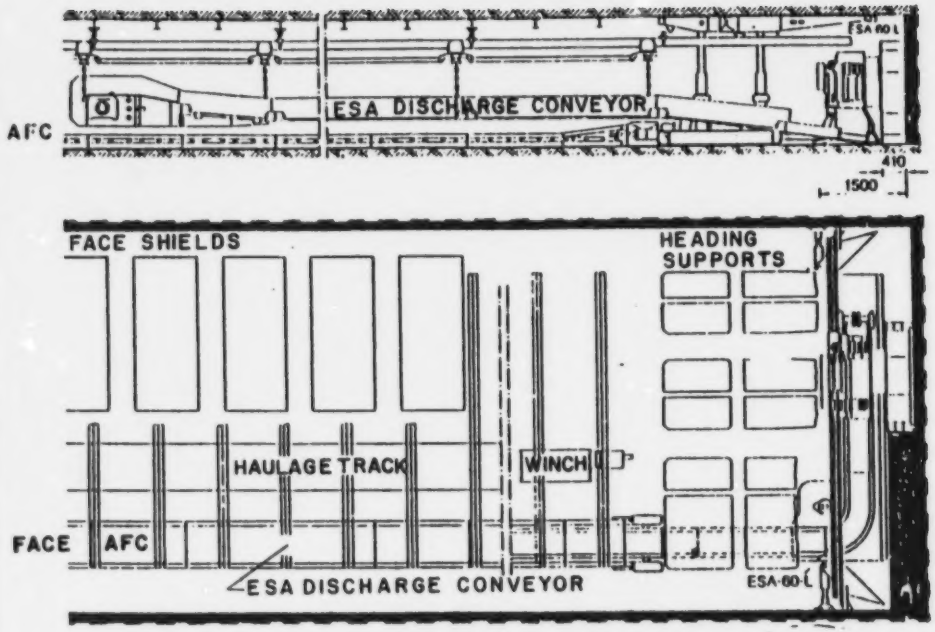


WESTFALIA VME ROADHEADER WITH POWERED SUPPORTS
IN ROADWAY DRIVAGE

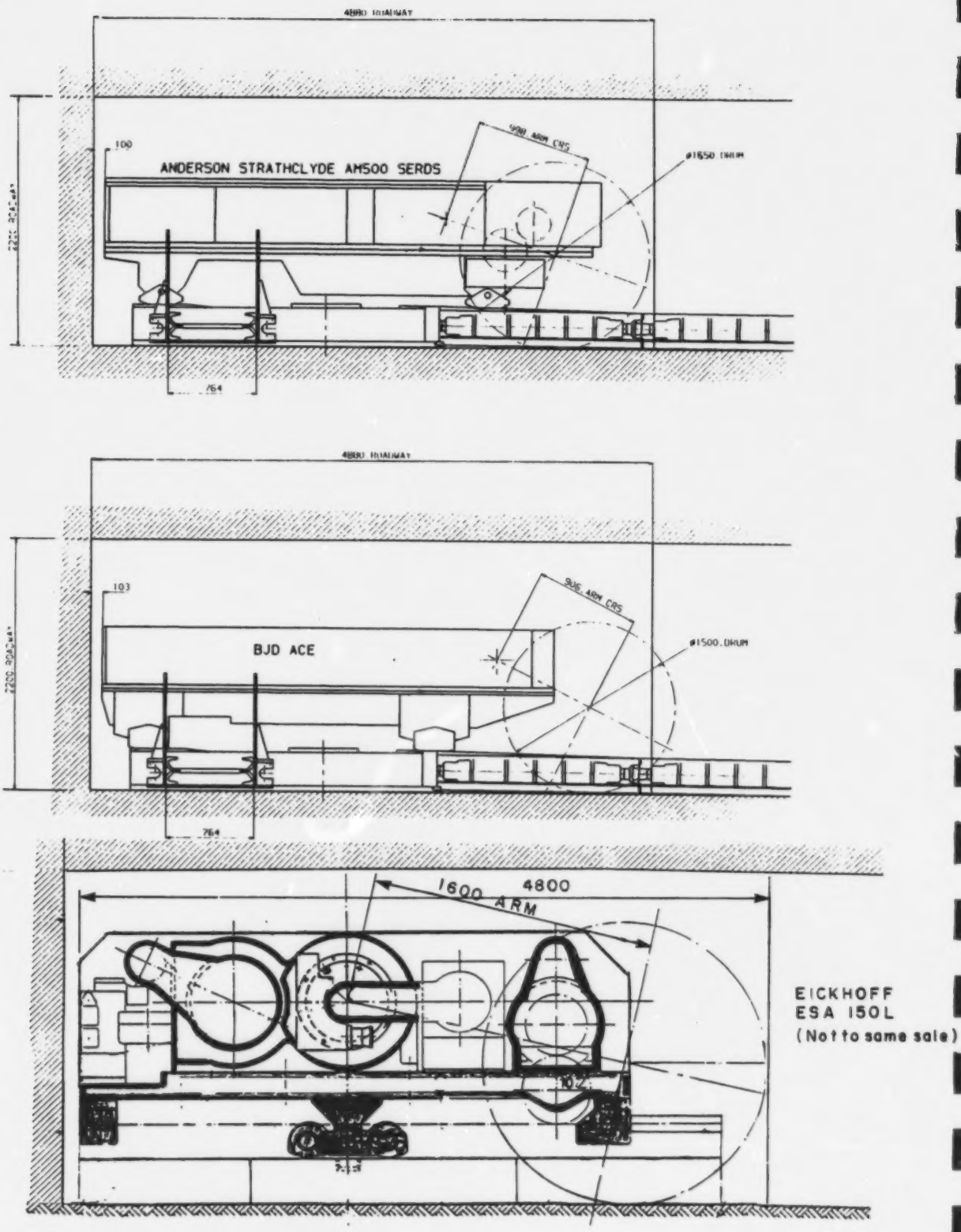
FIGURE 5-24

(Source: Westfalia)





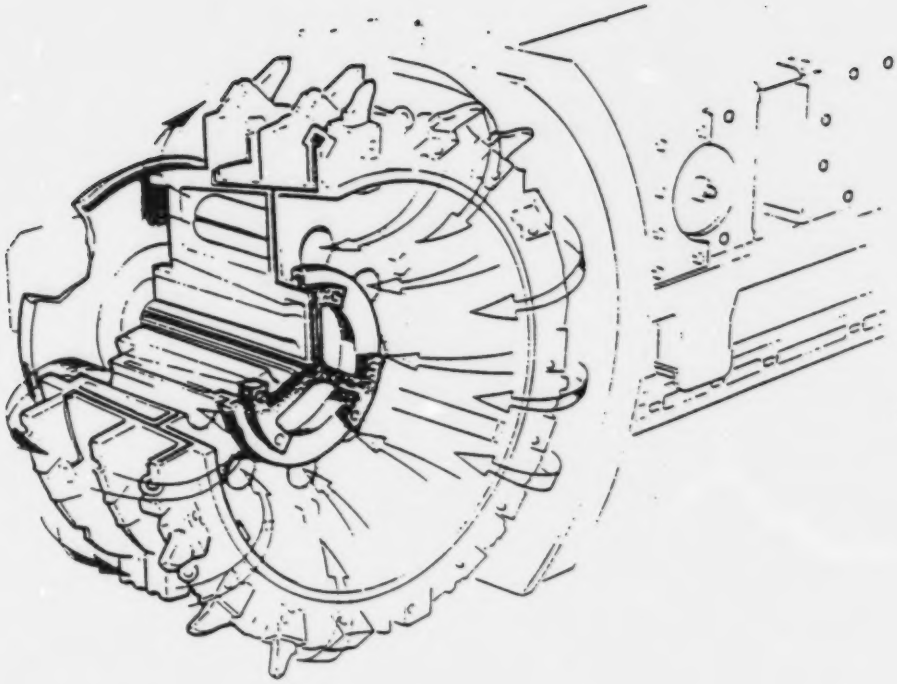
DRIVAGE SEQUENCE INCLUDING CONVEYOR POSITIONING AND SIMULTANEOUS FACE DRIVAGE AND INSTALLATION (Source: Eickhoff)

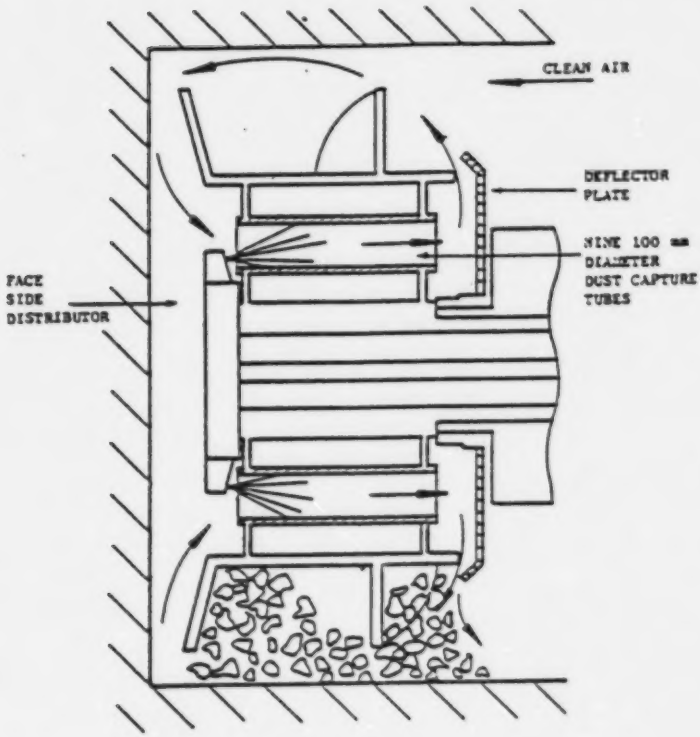


SHORT SINGLE ENDED RANGING DRUM SHEARERS

FIGURE 5-26

(Source: Ref.A13,C6)



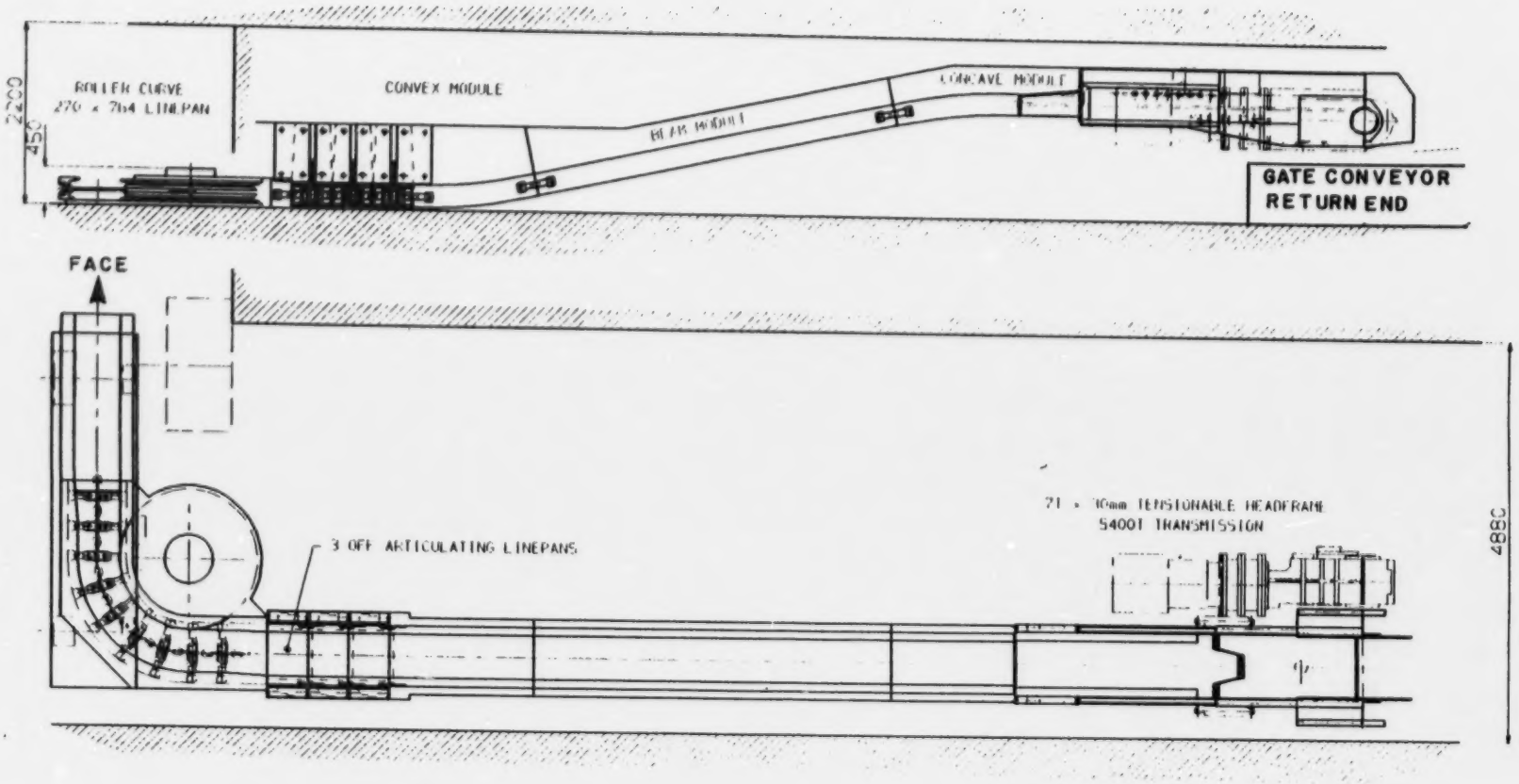


ROTARY AIR CIRCULATION CUTTING DRUM

(Source: Ref.D19)

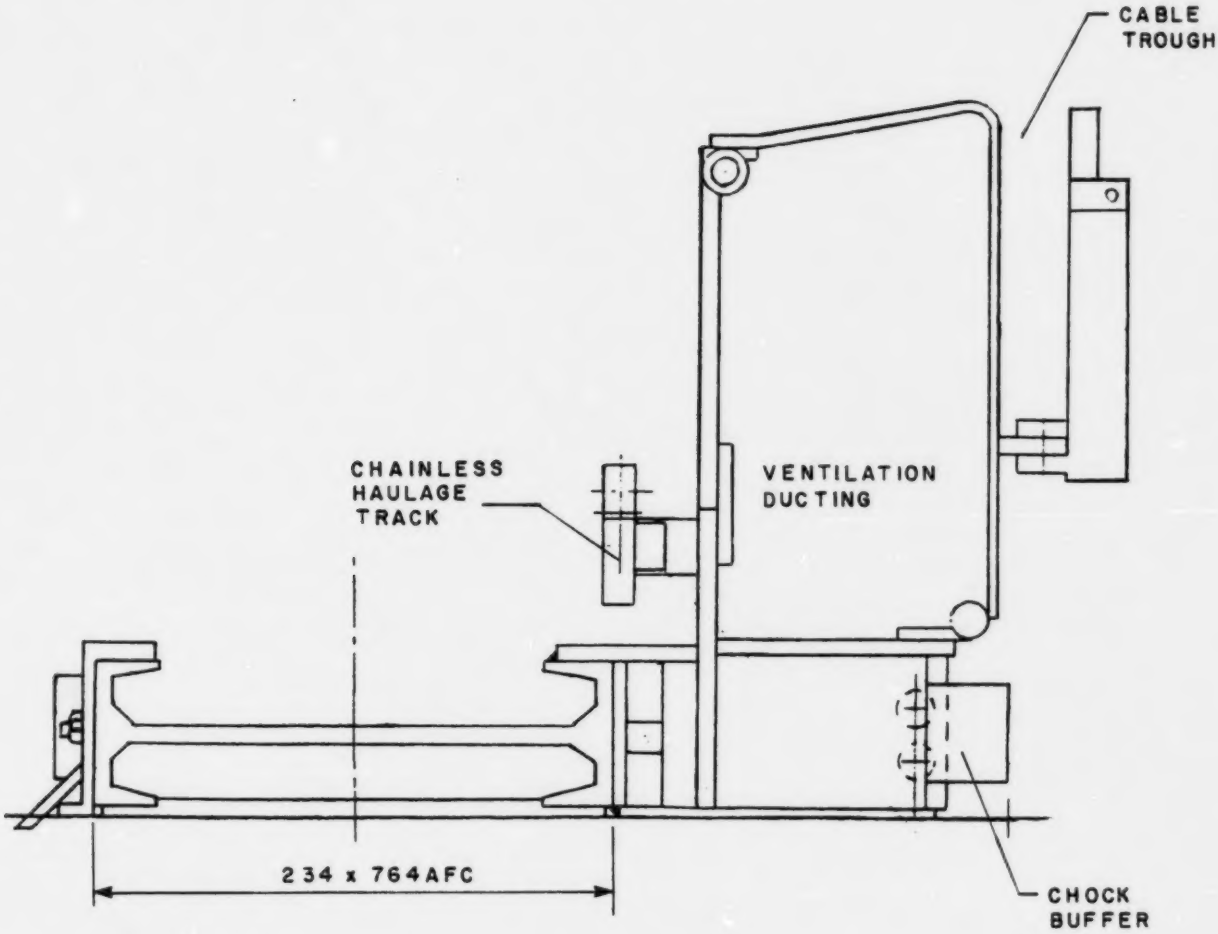
FIGURE 5-27

FIGURE 5-28



CURVED AFC SHOWING ROADWAY SECTION

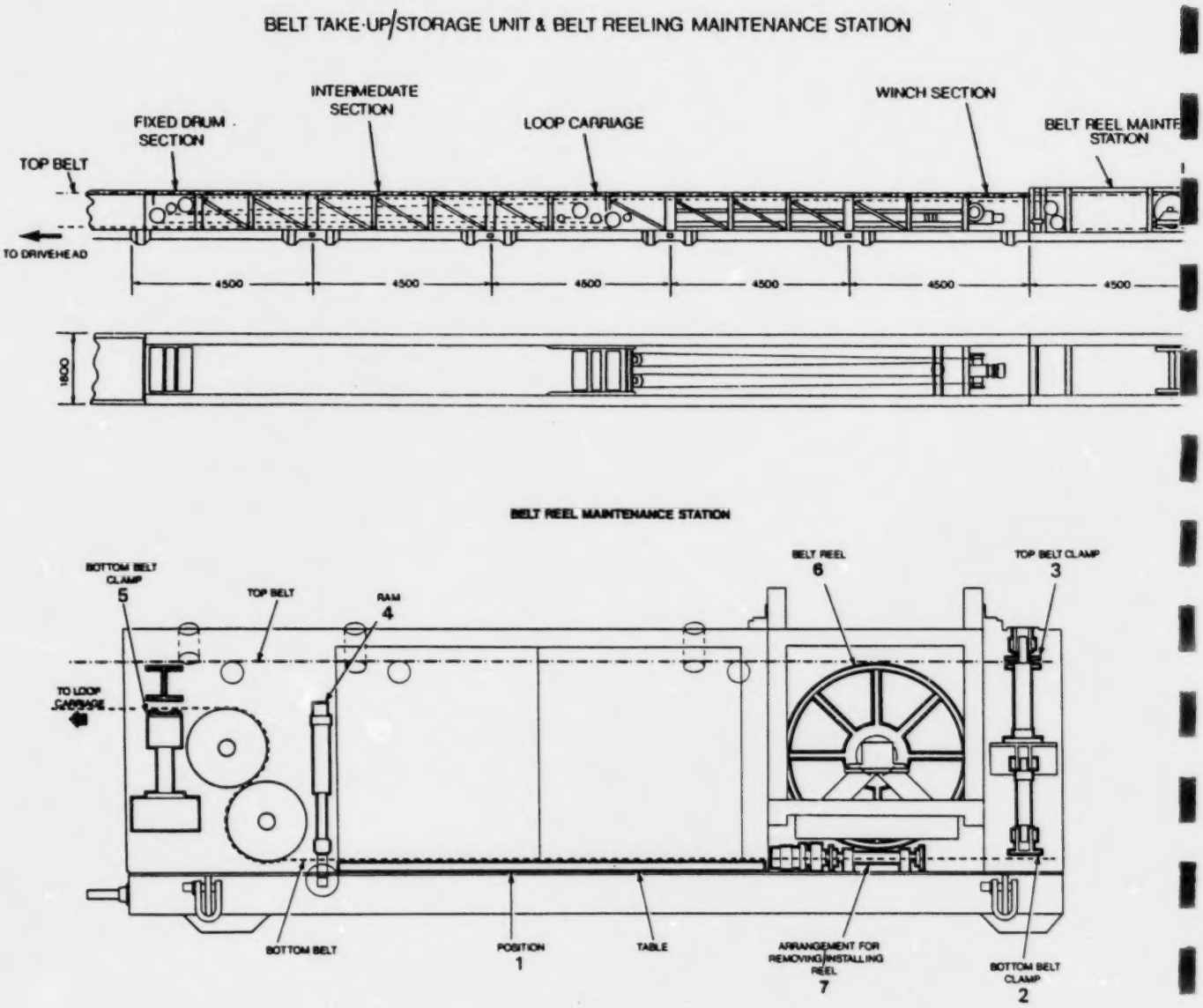
(Source: Ref.A13)



GOAFSIDE AFC FURNISHINGS

(Source: Pitcraft)

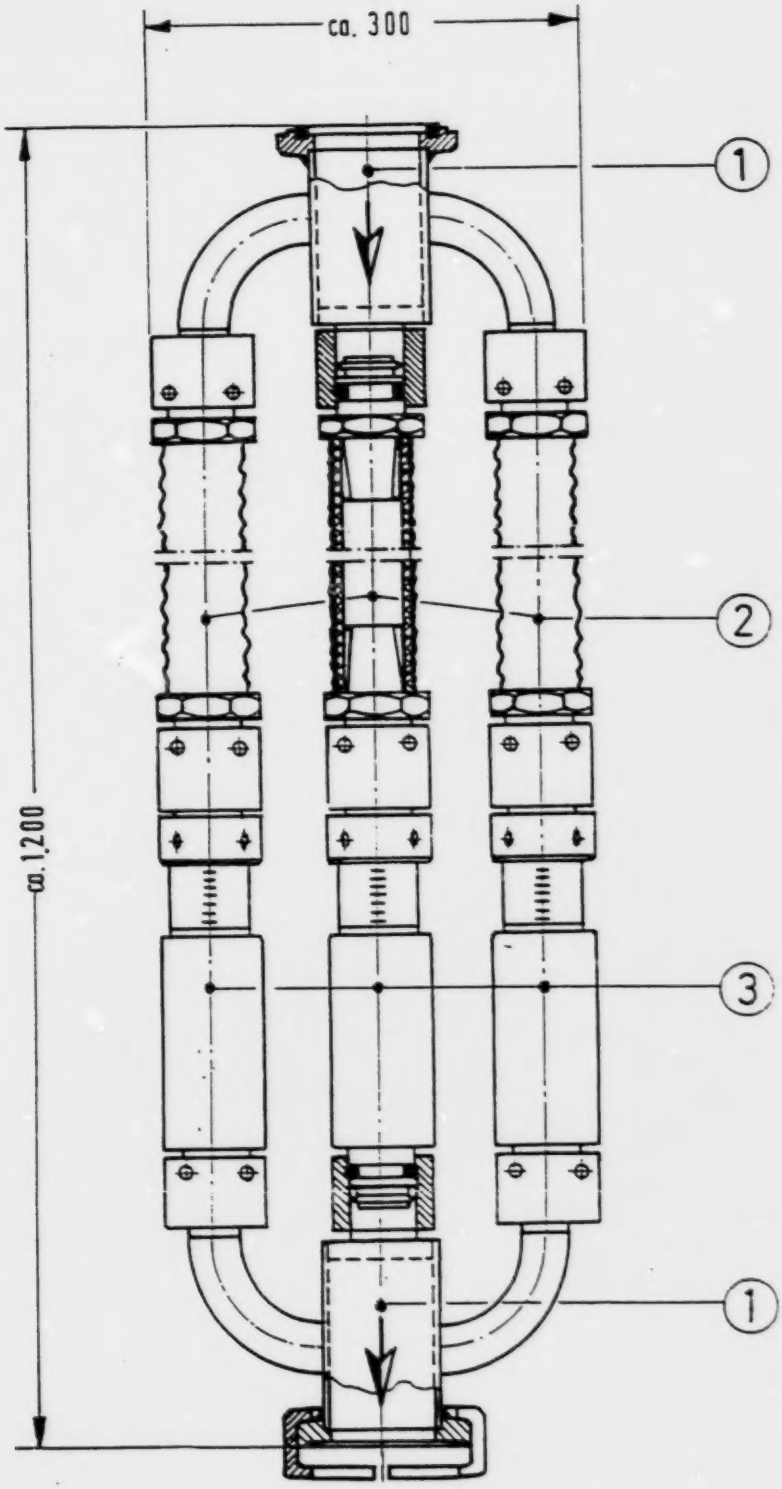
FIGURE 5-29



AUTOMATIC BELT STORAGE UNIT AND BELT REAL MAINTENANCE STATION

FIGURE 5-30

(Source: FSW)



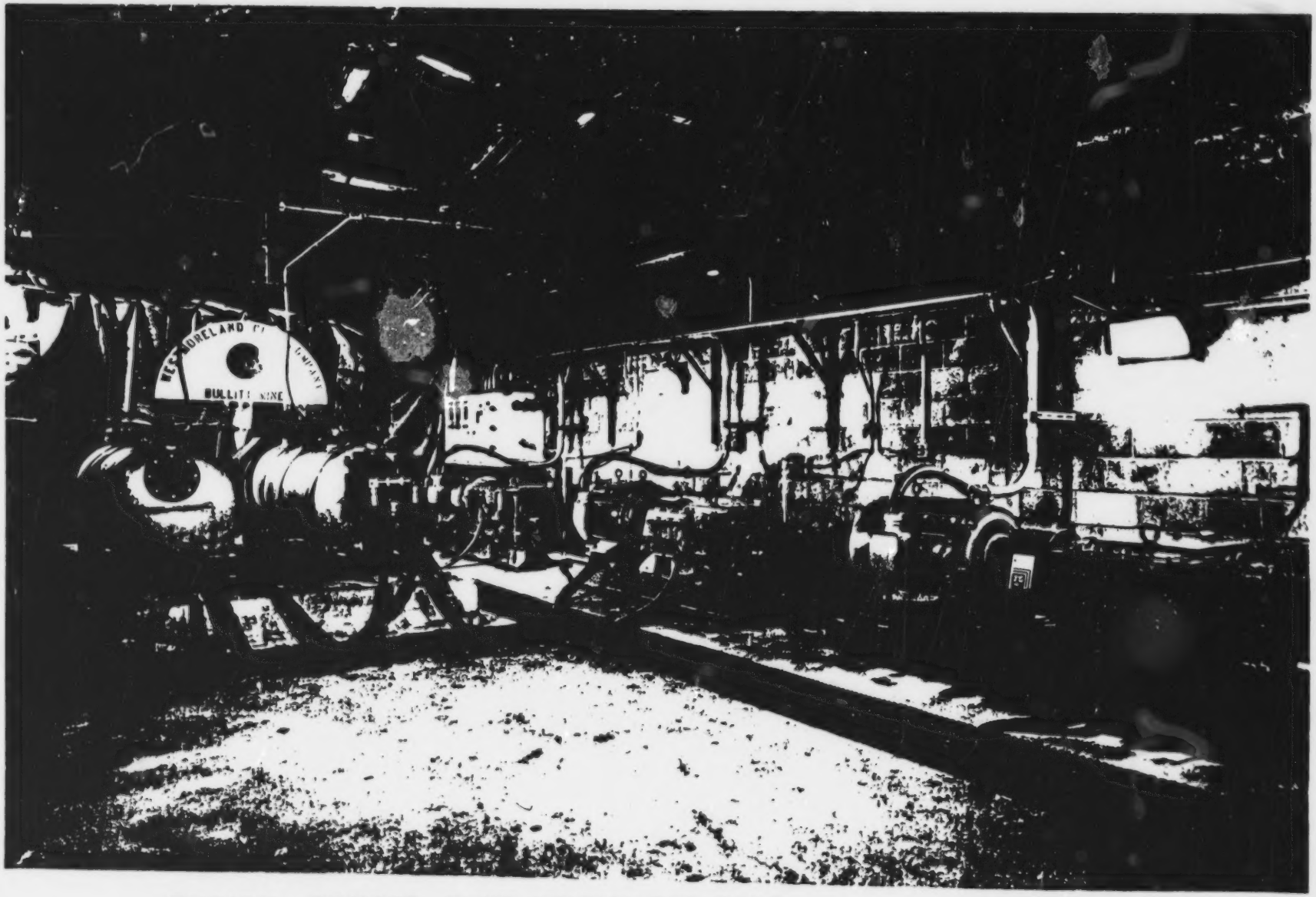
1 Adapter manifold for low pressure return pipe nominal bore 80 mm
2 Hose nominal bore 32 mm
3 Relief valve nominal bore 32 mm each one 150 l/min

RETURN VALVE FOR REMOTE PUMP STATIONS

(Source: Hamacher)

FIGURE 5-31

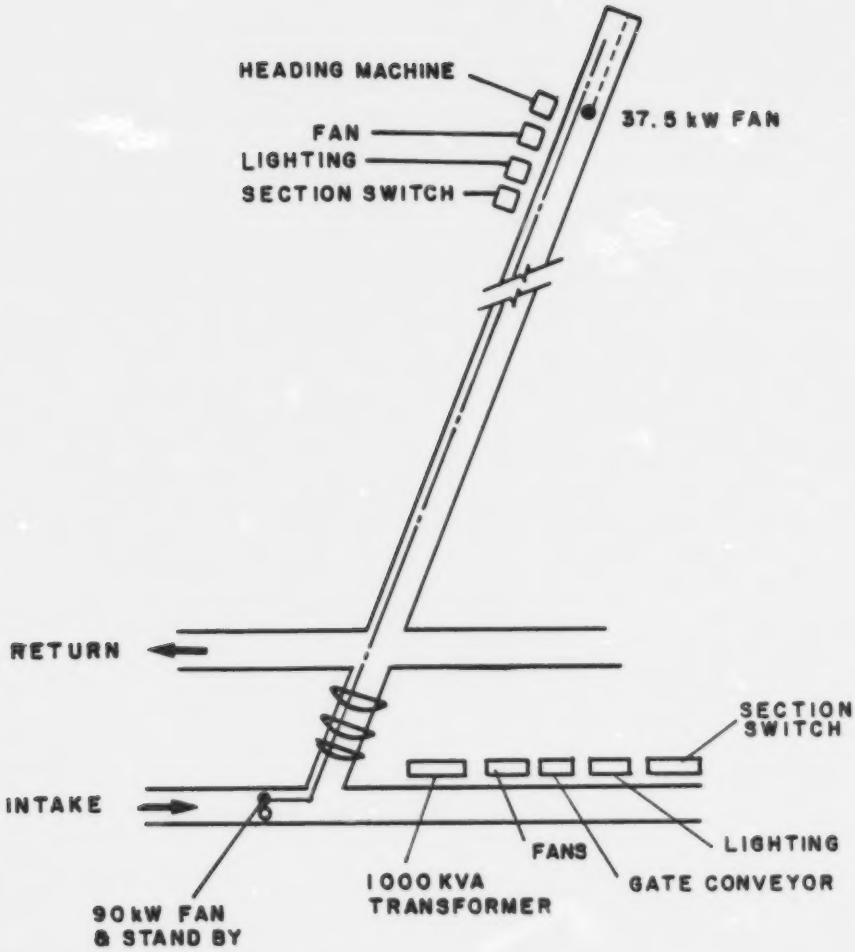
FIGURE 5-32



TYPICAL ROMOTE PUMP STATION FOR FACE POWER SUPPORTS

(Source: Hauhinco)

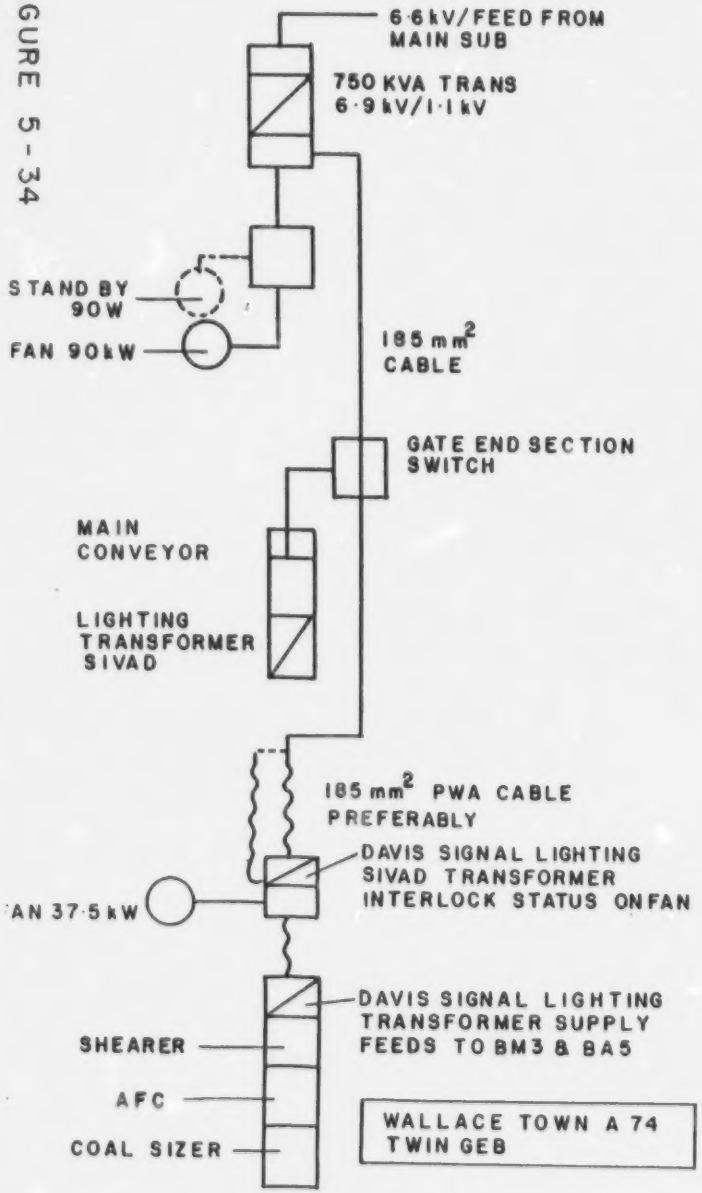
Hauhinco



LOCATION OF MAJOR ELECTRICAL POWER SUPPLY UNITS
(DEVELOPMENT)

(Source: OBED Coal)

FIGURE 5-33



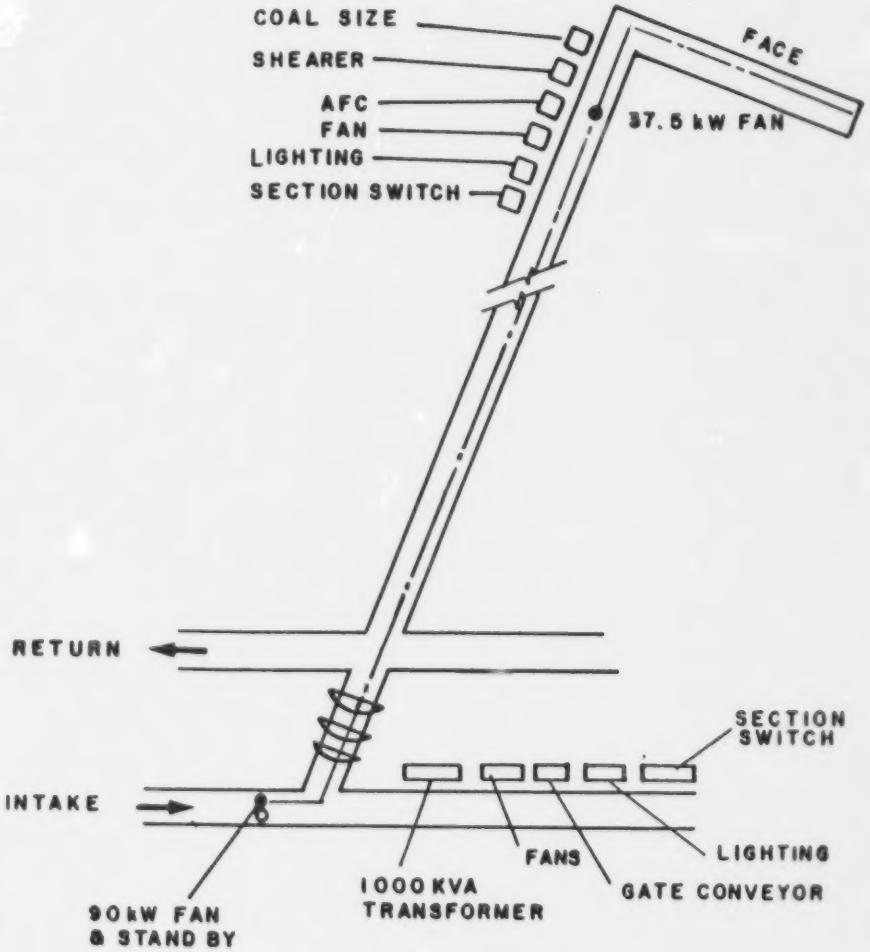
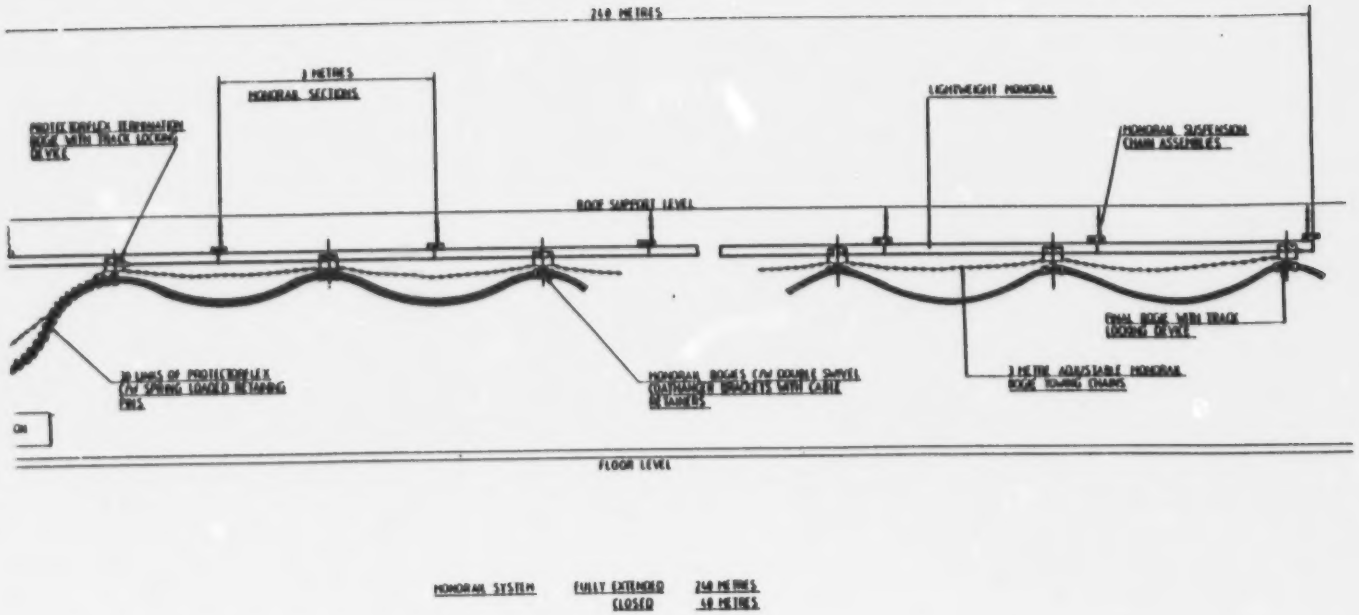


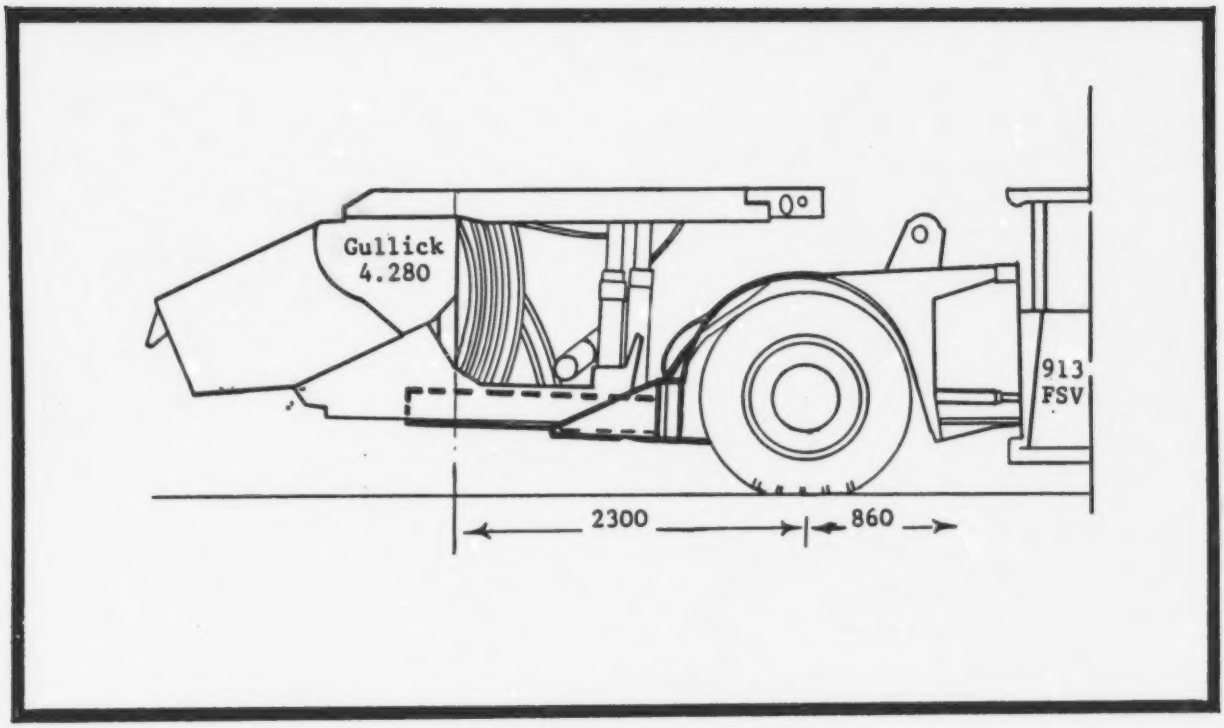
FIGURE 5-34

SINGLE ENTRY FACE POWER SCHEMATIC AND EQUIPMENT LOCATION (Source: OBED Coal)



CABLE & HOSE MONORAIL HANDLING SYSTEM (Source: Ref.A13)

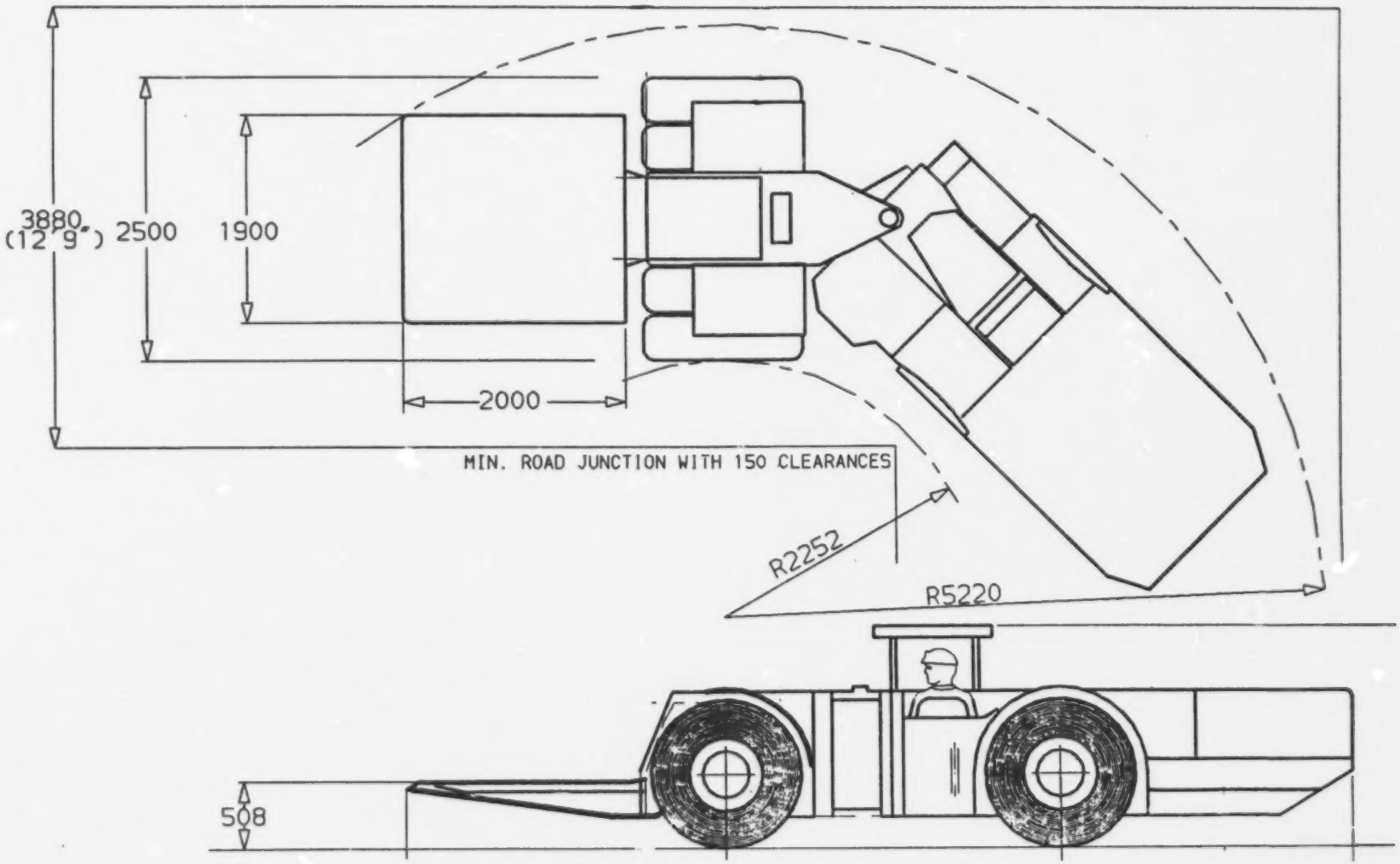
FIGURE 5-35



EIMCO 913 HEAVY DUTY TRANSPORTER SHOWING POWER SUPPORT CARRIER

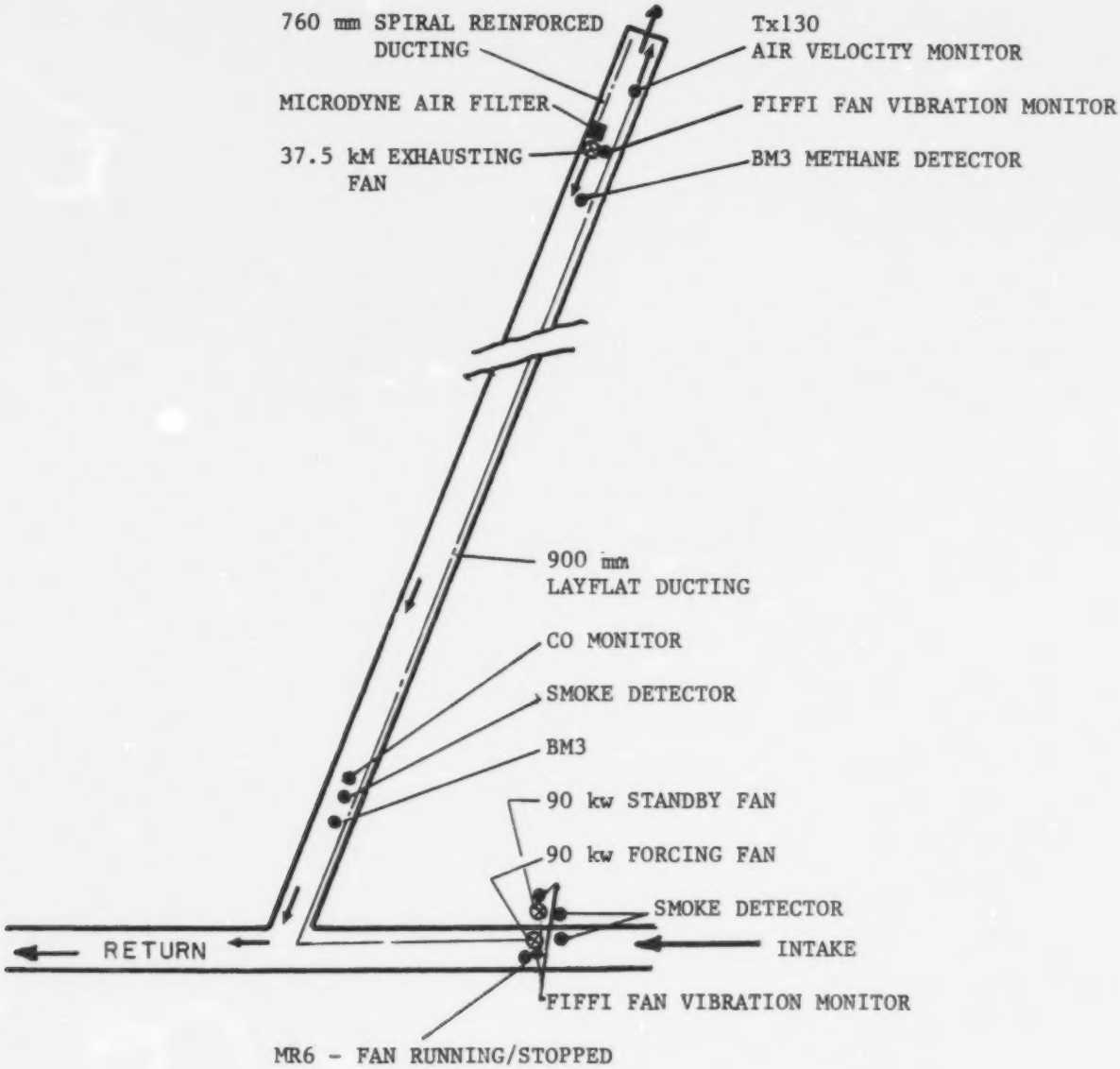
FIGURE 5-36

(Source: Eimco)



20 TONNE HEAVY DUTY TRANSPORTER (Source: Eimco)

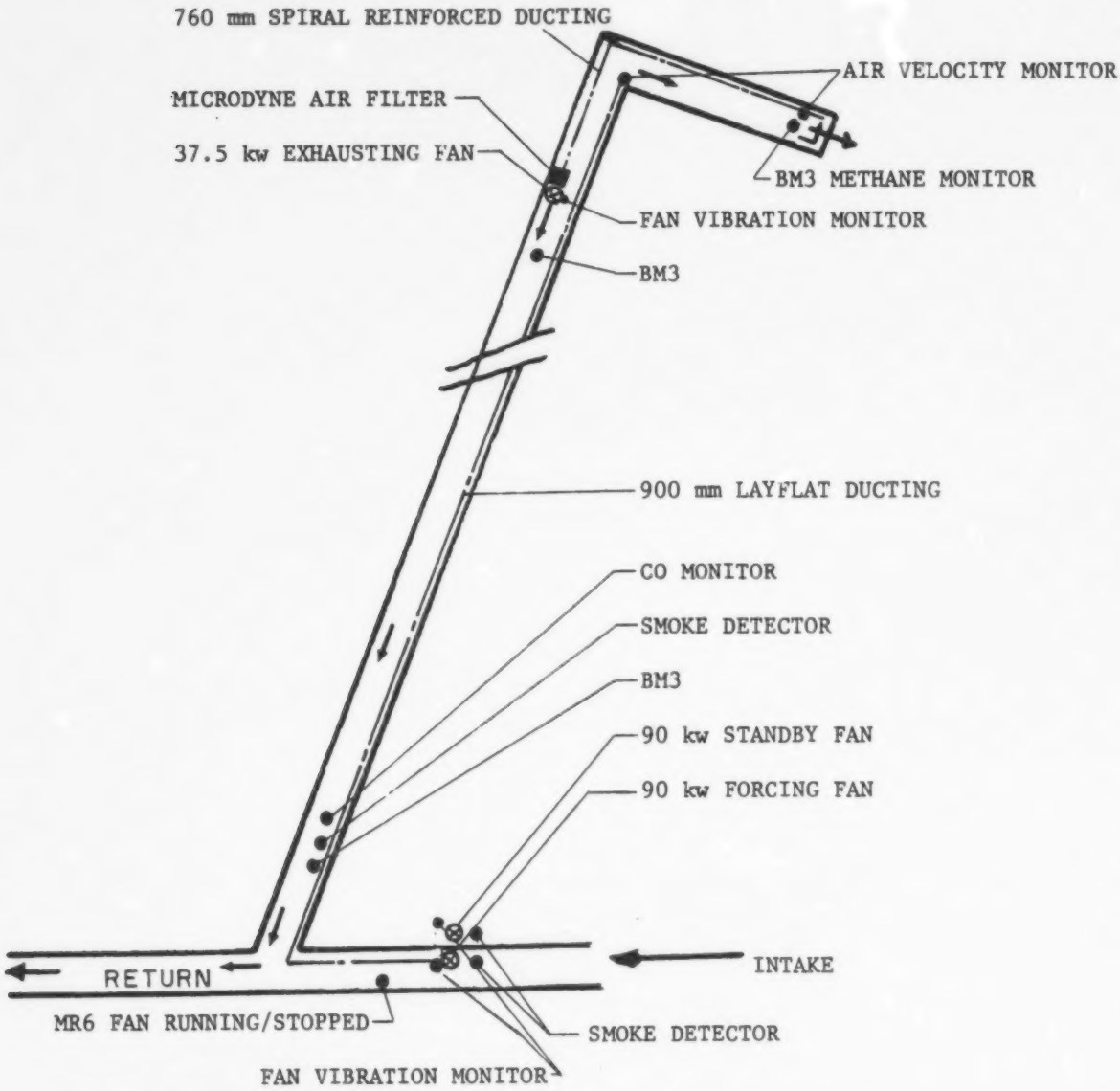
FIGURE 5-37



VENTILATION & MONITORING SYSTEM
ROADWAY DEVELOPMENT

FIGURE 5 - 38

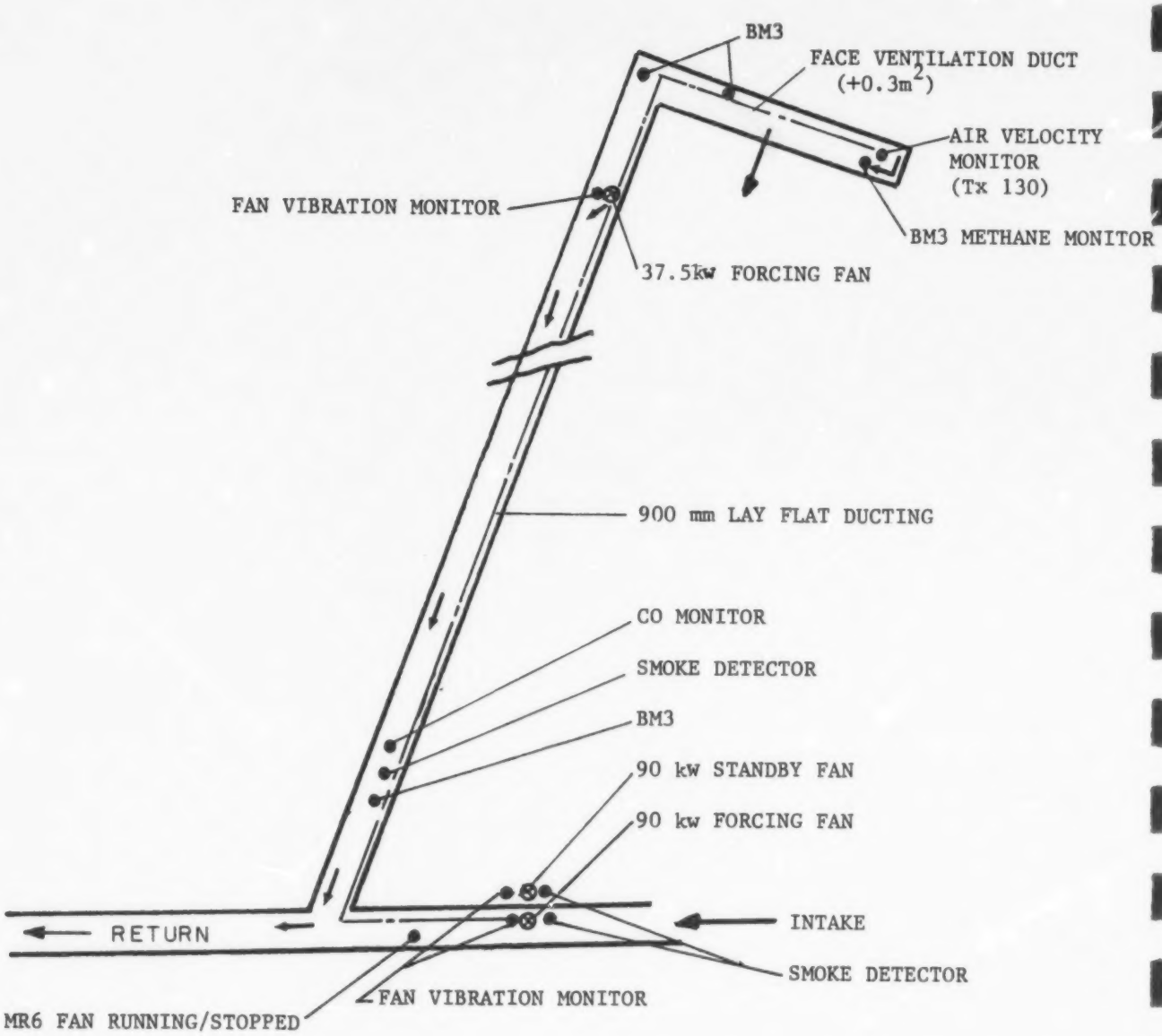
(Source: Monenco)



VENTILATION & MONITORING SYSTEM
FACE LINE DRIVAGE

(Source: Monenco)

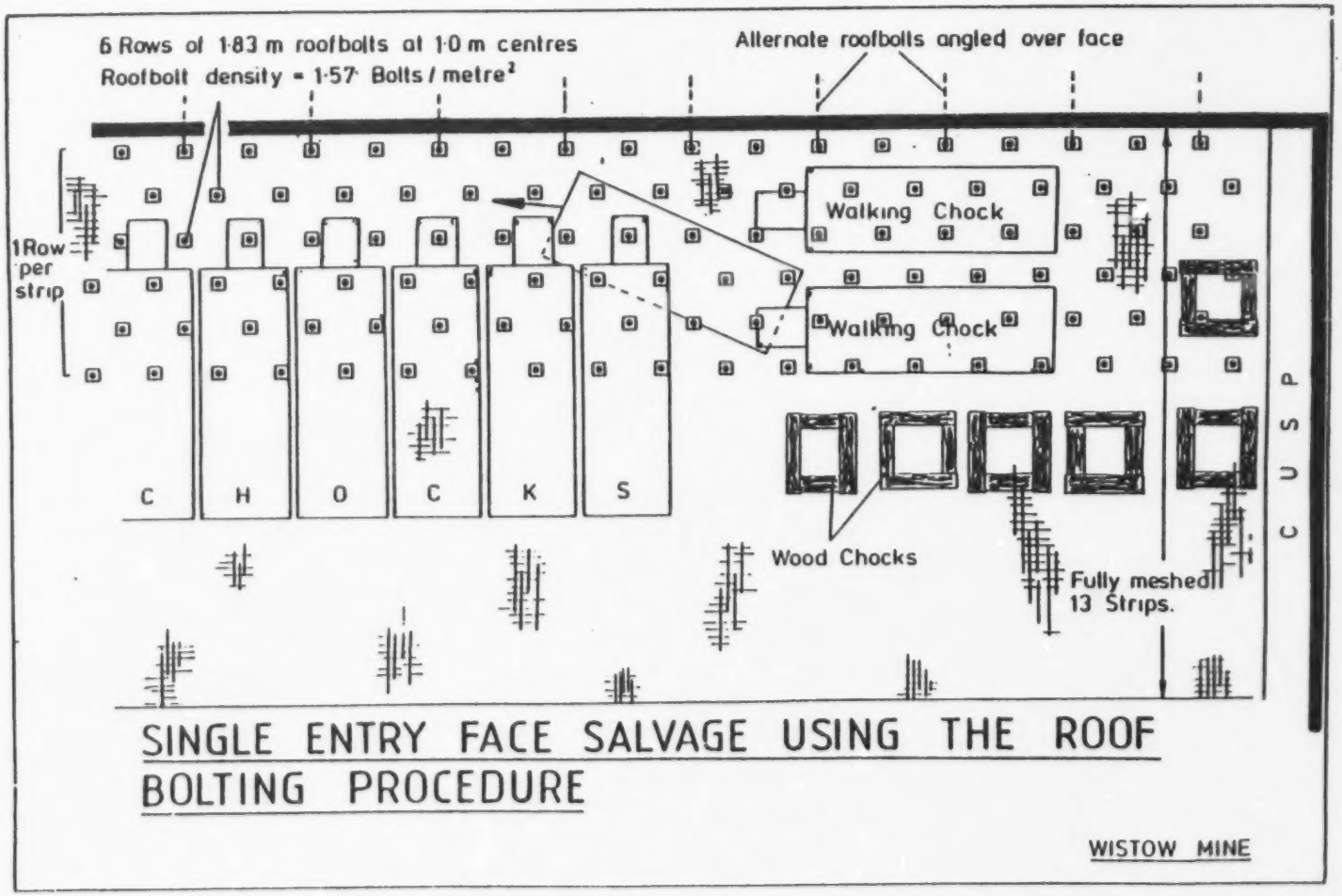
FIGURE 5-39



VENTILATION & MONITORING SYSTEM
RETREATING FACE

FIGURE 5-40

(Source: Monenco)



FACE SUPPORT SALVAGE (Source: Ref.A3)

FIGURE 5-41.

TABLE 5-1

SUMMARY OF UNIAXIAL STRENGTH TESTS

MINE	ROCK TYPE	UNIAXIAL COMPRESSIVE STRENGTH (MPa)
Lingan	Coal (perp. bedding)	36
	Siltstone	49
	Sandstone	80
	Mudstone	59
Prince	Coal (perp. bedding)	22
	Med. Grained Sst.	56
	Fine Grained Sst.	143
	Siltstone	82
	Mudstone	89

TABLE 5-2

ESTIMATED STRESS AND YIELD ZONES IN RIB PILLARS

Panel Width (m)	Pillar Width (m)	Depth (m)	Estimated Width Yield Zone (m)	Estimated Peak Vertical Stress (MPa)	Estimated Vertical Stress in Core (MPa)
30	30	50	2.0	10.5	1.25
		75	2.2	13.0	2.0
		100	2.8	15.8	2.8
30	15	100	2.8	15.8	4.8
76	61	110	3.6	16.8	3.0

TABLE 5-3 Type and support of gate roadways in the European coalfields

	NCB		KS		STBV (Ruhr)	
	Type	Roadway support*	Type	Roadway support	Type	Roadway support
Advancing system gate roadways (used once), driven:						
— 25 m ahead of longwall face	21%	50% H27 kg/m; s = 0,6 m A = 11 m²; SS = 33 50% TH 25 kg/m; s = 0,6 m A = 11 m²; SS = 30	25%	TH29 kg/m; s = 0,6 m A = 12,2 m²; SS = 42	35%	TH36 kg/m; s = 0,8 m A = 16,8 m; SS = 33
— on same line as longwall face	—	—	—	—	6%	TH36 kg/m; s = 0,8 m A = 16,8 m²; SS = 33
— on same line and support set behind longwall face	69%	H27 kg/m; s = 0,6 m A = 11 m²; SS = 33	70%	Rails* 45 kg/m on wooden pegs, s = 0,6 m, A = 11 m²	45%	TH36 kg/m; s = 0,8 m A = 16,8 m²; SS = 33
Gate roadways used twice	—	—	—	—	20%	TH36 kg/m; s = 0,8 m A = 16,8 m²; SS = 33

	STBV (Sarre)		CDF (Lorraine)		CDF (Nord et Pas de Calais)	
	Type	Roadway support	Type	Roadway support	Type	Roadway support
Advancing system gate roadways (used once), driven:						
— 25 m ahead of longwall face	32%	TH29 kg/m; s = 0,8 m A = 13 m²; SS = 30	—	—	—	—
— on same line as longwall face	—	—	60%	40% rock-bolting** 60% TH25 kg/m**, s = 1,2 m A = 15 m²; SS = 18	10%	TH26 kg/m****; s = 0.7 m A = 11, 3 m²; SS = 37
— on same line and support set behind longwall face	—	—	—	—	—	—
Retreating system gate roadways (used once)	45%	TH29 kg/m; s = 0,8 m A = 16 m²; SS = 27	20%	Trapezoidal sets*** (I-section) 14 kg/m, s = 1,2 m A = 12 m²; SS = 12	50%	TH26 kg/m****; s = 0.7 m A = 11,3 m²; SS = 37
Gate roadways used twice	23%	TH36 kg/m; s = 1 m A = 16 m²; SS = 27	20%	40% rock-bolting*** 60% TH25 kg/m**, s = 1,2 m A = 15 m²; SS = 18	40%	TH29 kg/m; s = 0,7 m A = 15,5 m²; SS = 32

*Roadway support: H = British H-section, *rigid type*
TH = Toussaint-Heintzman section, *yielding type*
s = steel sets spacing in the roadway
A = inner area of steel sets
SS = support steel spending (kg/m³)

*Rails arched to the shape of the roadway top half and resting on the wooden pegs used as ribside packing.

**1,2 rockbolt/m²; A = 12 m²

**30% of roadways have actually TH21 kg/m and 30% have TH29 kg/m. Steel props are often added to steel sets, especially when they are used twice.

***Legs are TH21 kg/m section, yielding type.

***1,5 rockbolt/m²; A = 12 m²

****65% of roadways have actually TH21 kg/m and 35% of roadways have TH29 kg/m

(Ref. Choquel 1986)

TABLE 5-4

SUPPORT TYPES ON SINGLE ENTRY FACES AT OPERATING MINES

MINE	SEAM THICKNESS	DEPTH	PANEL WIDTH	ROADWAYS	ROAD HEAD	FACE
Gretley	2.0 m	75 m	36 m	W straps and 4 x 1.5 m roofbolts 0.9 - 1.5 m spacing		2 leg 400 tonne shields 2 m centres
Bevercotes	1.50 m	N/A	60 m	2.8 m high, flat Top Arches	GD 5/325 roadhead anchor supports	GD G/240 chock support (modified)
Mansfield	2.3 m	665 m	45 m	5.1 x 2.92 m Donisthorpe arches 5.1 x 2.44 m flat Top Arches 1/2 m centers	4/280 shield roadhead anchor supports	4/325 chock shields 1.5 m centres
South Kirkby	1.6 m	415 m	35 m	4.88 m Hollybank beams 1.98 m 0.6 m interval		5/200 shield supports
Pye Hill	1.5 m	N/A	14 m	Donisthorpe type arches 1.1 m centres flat top arches		6/240 power supports
Measham	1.5 m	130 m	50 m	3.44 x 2.44 m arches of light section		
Cadley Hill	1.98 m	N/A	45 m	3.96 x 2.13 m Flat top arches 0.914 m spacing interlocking "weldgrip" and wood lagging	4/280T + 2/60T 4/280T + 1/30T chock shields	4/280T compact chock shields

TABLE 5-4 (Cont'd)

SUPPORT TYPES ON SINGLE ENTRY FACES AT OPERATING MINES

MINE	SEAM THICKNESS	DEPTH	PANEL WIDTH	ROADWAYS	ROAD HEAD	FACE
Ruhrkohle Rheinland	1.95 m	730 m	33 m	Proposed: B15, 6 arches	Proposed: roof bolts or sliding roof bars	2 leg Klockner-Becorit
Wistow	2.4 m (2.1 m mined)	310 m	35 m	Rectangular steel support	4 leg 280T compact shock	4 x 450 chock shields 4 x 650 chock shields
Wistow WA 42	2.1 m	364 m	45 m	Flat top arch		4 x 650 chock shields
Wistow A14	2.1 m	310 m	55 m	0.15 m x 0.15 m RSJ+ 2 legs meshed & strutted at 0.9 m centres & bolted between sets	3 Dowty 4 x 280T chock shields with extended conopies	Dowty 4 x 450T shields
Stolzenbach	3.3 m	160 m	30-50 m			Two leg shields G490-15 7/34
Whitwick	1.5 m	76-137 m		Flat top arch 1.2 centres		
Sherwood	3.4 m	600 m	55 m	.15 x .126 RSJ in strutted and lagged on on 1.3 centres. Bulb 2.3 m long full column 24 mm rebar set between supports	2 x Dowty 4 x 280J power supports with extended forward forward contilever	4 x 370 chock shields
Prince Longwall Retreat	2.3 m	230 m	113 m	Rectangular 0.15 x 0.15 x 4.27 m RSJ with pin jointed steel legs	2 x 4 leg anchor chocks	2 x 320 + shield

TABLE 5-5

POWER REQUIREMENTS

Heading/Face		Outbye Roadway	
Development (Figure 5-33)			
Heading Machine	185 kW	Gate Conveyor	112 kW
Exhausting Fan	37.5 kW	Forcing Fan	90 kW
Lighting Transformer	-	Lighting Transformer	-
Communications Consol	-	Communications Consol	-
Section Switch	-	1000 kVA Transformer	-
		Section Switch	-
Retreat Mining (Figure 5-34)			
Shearer	300 kW	Gate Conveyor	112 kW
AFC	200 kW	Fan	90 kW
Fan	37.5 kW	Standby Fan	90 kW
Coal Sizer	112 kW	Lighting T/F	-
Lighting T/F	-	Comunications Consol	-
Section Switch	-	Section Switch	-
		1000 kVA Transformer	-

TABLE 5-6

FACE CYCLE TIMES
(One web back operations)

Operation	Cutting Length (m)	Speed (m/min)	Time (mins)
Cut top coal - Main gate to blind end	25	8	3.13
Adjust Drum	-	-	1.50
Cut bottom coal-blind end to main gate	25	12	2.08
Advance Support	30#	-	3.00
Advance Shearer/AFC	-	-	3.00
			12.71
Operational Delays (10%)			1.27
		Total (say)	14.0 mins.

At 95% availability, cycles per shift = $6 \times 0.95 \times \frac{60}{14} = 24.4$

(Assumes 6 hours available at face)

Allow for pick changes, ventilation moves and miscellaneous delays at 60% utilization.

No. of cycles per shift = $0.60 \times 24.4 = 14.6$

TABLE 5-7(a)

SUMMARY SPECIFICATION FOR SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

PRINCE MINE
ROADWAY DRIVAGE & FACE LINE DEVELOPMENT

Depth of Cover	60 m
Seam Height	2.3 m
Face Length	25 m - 30 m
Pillar Width	20 m - 30 m
Panel Length	1000 m
Gradient	0.5° - 1.5°
Roadway Width	5 m
Face Line Width	6 m
Drivage Machine	- Westfalia VME Raodheader - 5.0 m wide - 120 kW cutting power - curved gathering and discharge conveyor - 0.9 in. diameter cutting drum with pick face flushing
Coal Clearance	- FSW In-Seam modular conveyor - 1.07 m wide belt - 112 kW drive - automatic loop take up and belt reel station - 100 m belt storage capacity - 990 tph capacity
Roadway Supports	- 3 powered anchor chocks behind VME supporting heading face, carrying girder setting device at rear - 150 mm x 150 mm RSJ roof beams 5 m long, supported on two 150 mm x 150 mm steel legs bolt/clamped to roof beam, set at 1.0 m intervals

TABLE 5-7(a) (Cont'd)

SUMMARY SPECIFICATION FOR SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

PRINCE MINE
ROADWAY DRIVAGE & FACE LINE DEVELOPMENT

	- 4 - 1.8 m long Swellex rock bolts set between steel sets using stoper drilling equipment - roof and sides meshed - foot blocks used under steel legs
Materials Transport	- Eimco 913 FSV with attachments

Ventilation	- 90 kW 914 mm primary forcing fan located in intake roadway
	- 914 mm lay flat ducting
	- primary flow 8 m^3/s
	- 37.5 kW 760 mm exhausting fan located 10 m outbye end of 760 mm primary ducting, using spiral reinforced ducting
	- exhausting from heading face at 4.5 m^3/s
	- microdyne dust extractor in exhausting fan circuit
	- on primary fan circuit
	  - Air velocity (TX130) at duct exit
	  - BM3 methane monitor outbye secondary system
	  - CO and smoke detector at outbye end of single entry
	  - smoke detector at intake to primary fan
	  - fan vibration monitor on primary fan
	  - power on/running status on primary fan

TABLE 5-7(a) (Cont'd)

SUMMARY SPECIFICATION FOR SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

PRINCE MINE
ROADWAY DRIVAGE & FACE LINE DEVELOPMENT

	- on secondary fan circuit - fan vibration monitor on secondary fan - power on/running status on secondary fan - when driving face line, add BM3 at face heading and TX 130 in secondary fan outlet	
Manpower	Heading machines	4
	Rock Bolting	2
	Electrician	.5
	Mechanic	.5
	Materials Supply	1
	Gate Belt Conveyor	1
	Supervision	1
		10
Peformance	15 m/shift	

TABLE 5-7(b)

SUMMARY SPECIFICATION FOR SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

PRINCE MINE RETREATING FACE

Depth of Cover	60 m
Seam Height	2.3 m
Face Length	25 m - 30 m
Pillar Width	20 m - 30 m
Panel Length	1000 m
Gradient	0.5° - 1.5°
Roadway Width	5 m
Shearer	- BJD ACE (or AM500) DERDS - 375 (300) kW motor - 1.7 m dia. cutting drum equipped with back face flushing and RAC dust control - 1.05 m web - chainless haulage - short length machines - Pitcraft onboard water boost pump - maximum cutting speed 12 m/min
AFC/Stage Loader	- Halback & Braun (or Dowty Meco) curved chain conveyor - 200 kW two speed direct start motor - 990 tph capacity - total length 60 m - single inboard 30 mm chain 0.5 m flight spacing - 270 mm x 764 mm pan - speed 1.0 m/min - fixed discharge to gate conveyor - special spill plates incorporating 0.3 m^2 ventilation ducting

TABLE 5-7(b) (Cont'd)

SUMMARY SPECIFICATION FOR SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

PRINCE MINE
RETREATING FACE

	- Perard cable handler/trough - non-driven return end - underplated line pans
Face Supports	- Hemscheidt 2 leg 320 t shields with powered forward cantilever at 1.5 m spacing - remote power pack using 60 mm pressure line and 75 mm return line
Roadhead Supports	- 3 - Hemscheidt 2 leg 320 t shields with extended rigid canopies, or - 3-4 leg anchor chocks with extended beams and 5th leg at end of beam
Gate Conveyor	- as per development specification
Materials Handling	- as per development specification
Ventilation	- 90 kW primary forcing fan, 914 mm dia, located in intake roadway - 914 mm dia lay flat ducting - primary flow 8.0 m^3/s - 37.5 kW secondary forcing fan, 760 mm dia. in series with primary fan and located on gate section of curved AFC - secondary flow 5.0 m^3/s (4.5 m^3/s minimum) through face ventilation duct

TABLE 5-7(b) (Cont'd)

SUMMARY SPECIFICATION FOR SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

PRINCE MINE
RETREATING FACE

Monitoring	- BM3 methane monitors at blind end of face, mid face and roadway/face area - TX130 air velocity monitor in discharge end of face duct - fan vibration and power status/fan running monitors on secondary fan - CO & smoke detection at outbye end of single entry roadway - smoke detection at inlet to primary fan - fan vibrator and power status/fan running monitors on primary fan
Manpower	Shearer 2 Supports 1 Roadhead/Consol 1 Electrician .5 Mechanic .5 Materials 1 Gate Conveyor 1 Supervision 1 8
Performance	- 15 strips/shift - 1130 t/shift - 17950 ROM t/week - face OMS 169 t/MS

TABLE 5-4

SUPPORT TYPES ON SINGLE ENTRY FACES AT OPERATING MINES

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TABLE 5-4 (Cont'd)

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PART 6

CONCLUSIONS

6.1 CONCLUSIONS

This study has reviewed the application of single entry short longwall retreating (SESLR) systems used or in use at underground coal mines around the world, and the conditions and operations at the CBDC mines.

The following conclusions can be drawn.

1. The SESLR system has been used for over 8 years, and in 16 of the 17 mines where it has been or is being used, it has proved to be a safe and efficient method of working.

2. The SESLR system can be used for the mining of broken workings or remnant areas, for partial extraction mining and as a regular production system.

3. The successful and safe operation of the SESLR system requires the application and maintenance of the highest standards of ventilation and support, and also of conventional mining practices.

4. Comprehensive monitoring of the environment in the panel is required.

5. The SESLR system should be designed with the least number of components possible, and be kept as simple as possible.

6. The number of items of equipment in single entry roadway should be kept to the minimum.

7. Control of methane is the most important factor affecting the safety of the system.

8. Support of the single entry roadway, and the roadway face interface is also critical.

9. The SESLR system can produce coal at high productivities and make positive contributions to mine profits.

10. The SESLR system places great demands on the development operations, and requires that the development is organized, operated and monitored to the same if not greater level as the face mining operations.

11. The strata conditions and working standards are sufficiently good, and the methane emission levels sufficiently low at the Prince Mine, that the SESLR system can be applied in the designated areas with every expectation of a safe and successful result.

12. Although there are remnant areas of coal at both the Lingan and Phalen mines, conditions, standards and methane emission levels are such that, at this stage, these two mines cannot be considered for the use of the SESLR system.

13. The SESLR system can be worked with either separate machines for both roadway/face development, and for retreat mining, or with a single machine for both functions. In the latter case, which has not yet been tried anywhere, lower production levels can be expected from the retreating face.

PART 7

RECOMMENDATIONS

7.1 RECOMMENDATIONS

1. The single entry short longwall retreating system should be applied at Prince Mine in the designated area between the shoreline and the longwall workings west of the main deeps.

2. A detailed design for the complete system should be prepared by Prince Mine and CBDC Glace Bay staff based on the guidelines presented in this report and modified as necessary to meet regulatory conditions and equipment availabilitiies. This should be reviewed before implementation.

3. The initial operations should be based on the use of a heading machine for the drivage of the roadways and face line, with a shearer mining the retreating face. Once the system has been successfully proven, consideration should be given to the use of a single machine for both development and mining.

4. Roadway supports should include the use of rock bolts (Swellex type) initially as additional support. As conditions are assessed, consideration should be given to moving towards a fully rock bolted system.

5. A training session for management and labour, including the setting up of the system on the surface, during the commissioning process, should be a necessary part of the introduction of the SESLR system.

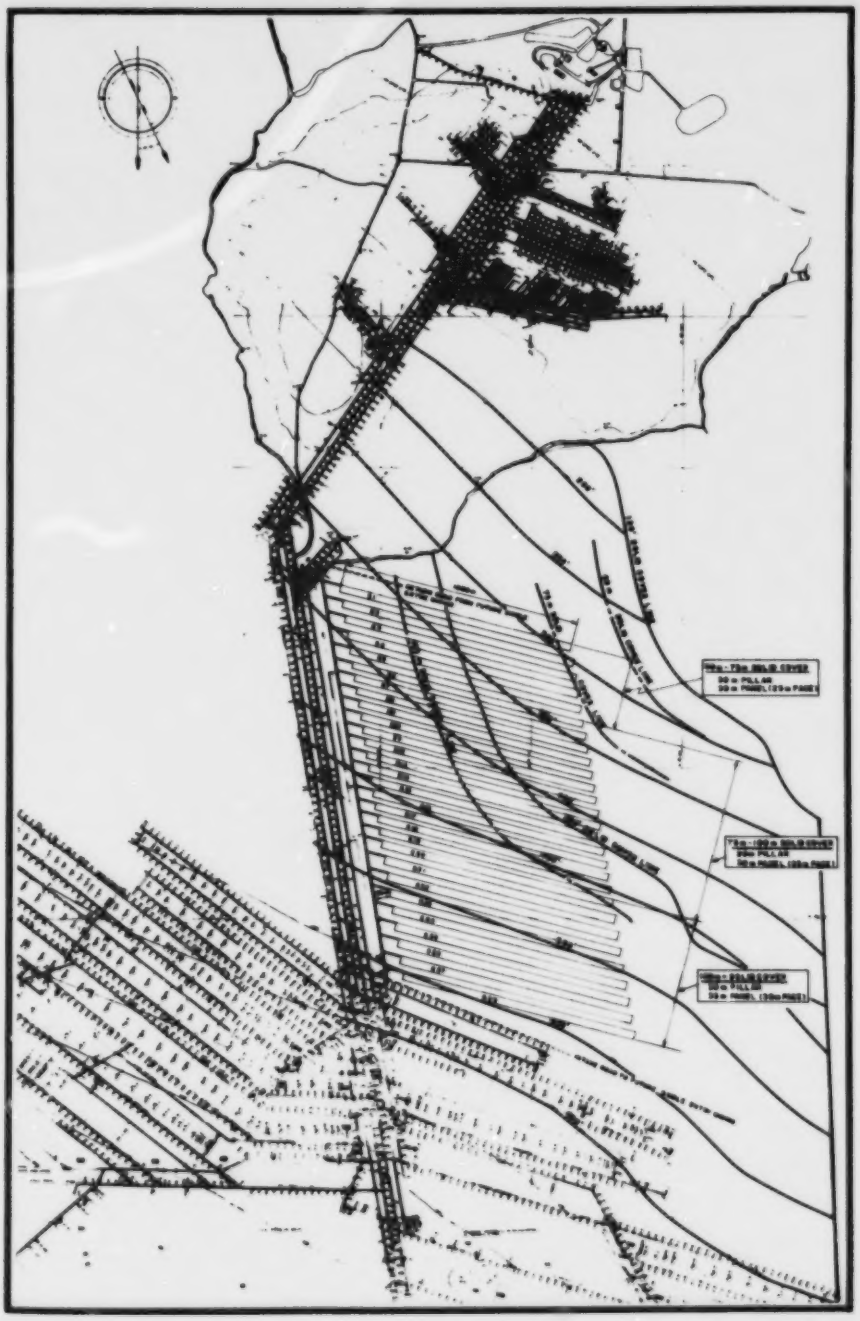
6. A detailed record of the initial operations of the SESLR system should be kept in order that the causes of any problems may be identified, remedial action taken and the system design modified. This should be subject to independent review.

Volume

2

Monenco

SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS



FINAL REPORT

BY

MONENCO CONSULTANTS LIMITED

MARCH 1988

VOLUME II

A REVIEW REPORT ON THE POSSIBLE APPLICATION TO BROKEN WORKINGS IN THE SYDNEY COALFIELD.

WORK ON THIS PROJECT WAS CONDUCTED UNDER THE AUSPICES OF THE DEPARTMENT OF ENERGY , MINE AND RESOURCE

THIS WORK WAS SUPPORTED (IN PART) BY THE FEDERAL PANEL ON ENERGY R & D (PERD).

DSS FILE NO. 03SQ. 23440-7-9022.

DSS CONTRACT NO. 23440-7-9022/01-SQ

EMR SCIENTIFIC AUTHORITY MR. G. HASLETT. CAPE BRETON COAL RESEARCH LABORATORY

SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS FOR BROKEN WORKINGS A REVIEW REPORT ON THEIR POSSIBLE APPLICATION IN THE SYDNEY COALFIELD NOVA SCOTIA. CANADA.

Final Report

by

Monenco Consultants Limited

March 1988

Volume II

Work on this project was conducted under the auspices of the Canada Centre for Mineral and Energy Technology, Energy, Mines & Resources Canada

This work was supported (in part) by the Federal Panel on Energy R&D (PERD)

DSS File No. 03SQ 23440-7-9022
Canmet Project Number 23440-7-9002/01-SQ
Canmet Scientific Authority Mr. G. Haslett

250 pp

MICROMEDIA

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1988-03-25
DSS 8374-1/4700

Mr. G. Haslett
Scientific Authority
CANMET
Cape Breton Coal Research Laboratory
210 George Street
SYDNEY, N.S.
B1P 1J3

Dear Mr. Haslett:

Re: Single Entry Short Longwall Retreating Systems
DSS Ref 03SQ 23440-7-9022

We have pleasure in submitting our final report for the above project, in ten bound copies, each of which contains an executive summary in English and French.

The report, which includes the comments made during the review of the draft report, comprises seven parts. Part 1 describes the background to the study; Part 2 deals with the study methods; Part 3 describes the existing CBDC mines and Part 4 gives a description of the Single Entry System and of existing and previous applications; Part 5 presents the design guidelines for the application of the system to the Prince Mine with our conclusions and recommendations being given in Parts 6 and 7 respectively. We have also included in the Appendices, as a separate volume, references, selected equipment brochures and strata control calculations.

We wish to acknowledge the invaluable assistance we have received from Golder Associates (Strata Control) and Obed Coal (Equipment). We have found the work on this project extremely interesting and trust that the report will be to your satisfaction. We shall be pleased to answer any questions arising from the report.

PROFESSIONAL ENGINEER
IAN R. MUIRHEAD
ALBERTA

Yours very truly,

MONENCO CONSULTANTS LIMITED

I.R. Muirhead, P.Eng
Manager, Mining

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PART 2 - STUDY METHODS

PART 3 - CBDC MINES AND POTENTIAL SITES

PART 4 - SINGLE ENTRY SHORT LONGWALL RETREATING SYSTEMS

PART 5 - SITE SPECIFIC DESIGN GUIDELINES

PART 6 - CONCLUSIONS

PART 7 - RECOMMENDATIONS

APPENDIX A

STRATA CONTROL DESIGN DATA

APPENDIX A1

Estimation of Strain over Single Entry Panels

Figure No.	Description
A1	Predicted Strain Profile above Single 30 m Wide Panel, 55 m Depth
A2	Predicted Strain Profile above Single 30 m Wide Panel, 60 m Depth
A3	Predicted Strain Profile above Single 30 m Wide Panel, 75 m Depth
A4	Predicted Strain Profile above Single 30 m Wide Panel, 100 m Depth
A5	Predicted Strain Profile above Single 35 m Wide Panel, 55 m Depth
A6	Predicted Strain Profile above Single 35 m Wide Panel, 60 m Depth
A7	Predicted Strain Profile above Single 35 m Wide Panel, 75 m Depth
A8	Predicted Strain Profile above Single 35 m Wide Panel, 100 m Depth
A9	Predicted Strain Profile above Single 40 m Wide Panel, 55 m Depth
A10	Predicted Strain Profile above Single 40 m Wide Panel, 60 m Depth
A11	Predicted Strain Profile above Single 40 m Wide Panel, 75 m Depth
A12	Predicted Strain Profile above Single 40 m Wide Panel, 100 m Depth
A13	Predicted Strain Profile above Single 50 m Wide Panel, 55 m Depth
A14	Predicted Strain Profile above Single 50 m Wide Panel, 60 m Depth
A15	Predicted Strain Profile above Single 50 m Wide Panel, 75 m Depth

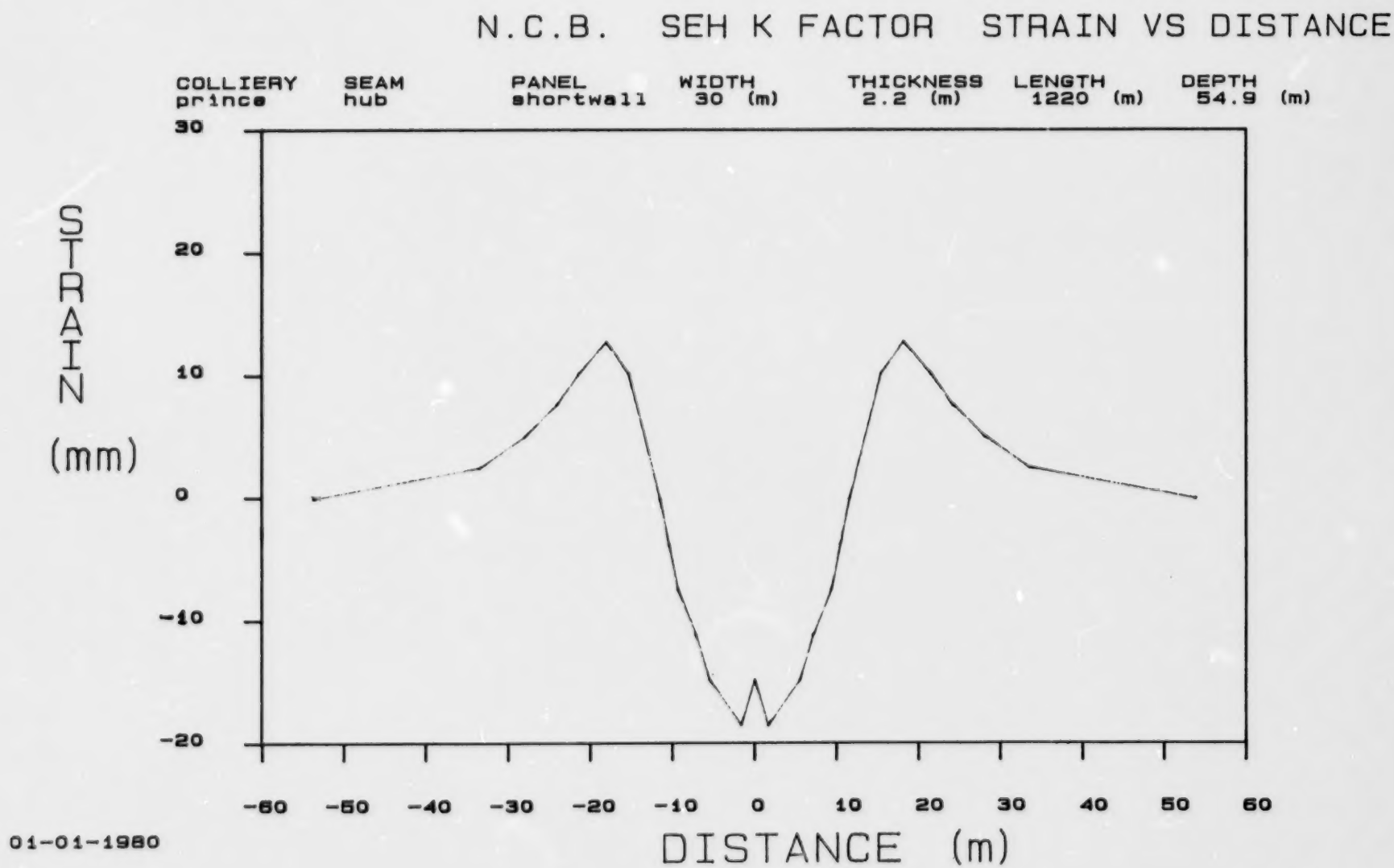

N.C.B. SEH K FACTOR STRAIN VS DISTANCE
COLLIERY prince
SEAM hub
PANEL shortwall
WIDTH 30 (m)
THICKNESS 2.2 (m)
LENGTH 1220 (m)
DEPTH 54.9 (m)
STRAIN (mm)
30
20
10
0
-10
-20
-60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60
DISTANCE (m)
01-01-1980

FIGURE A I

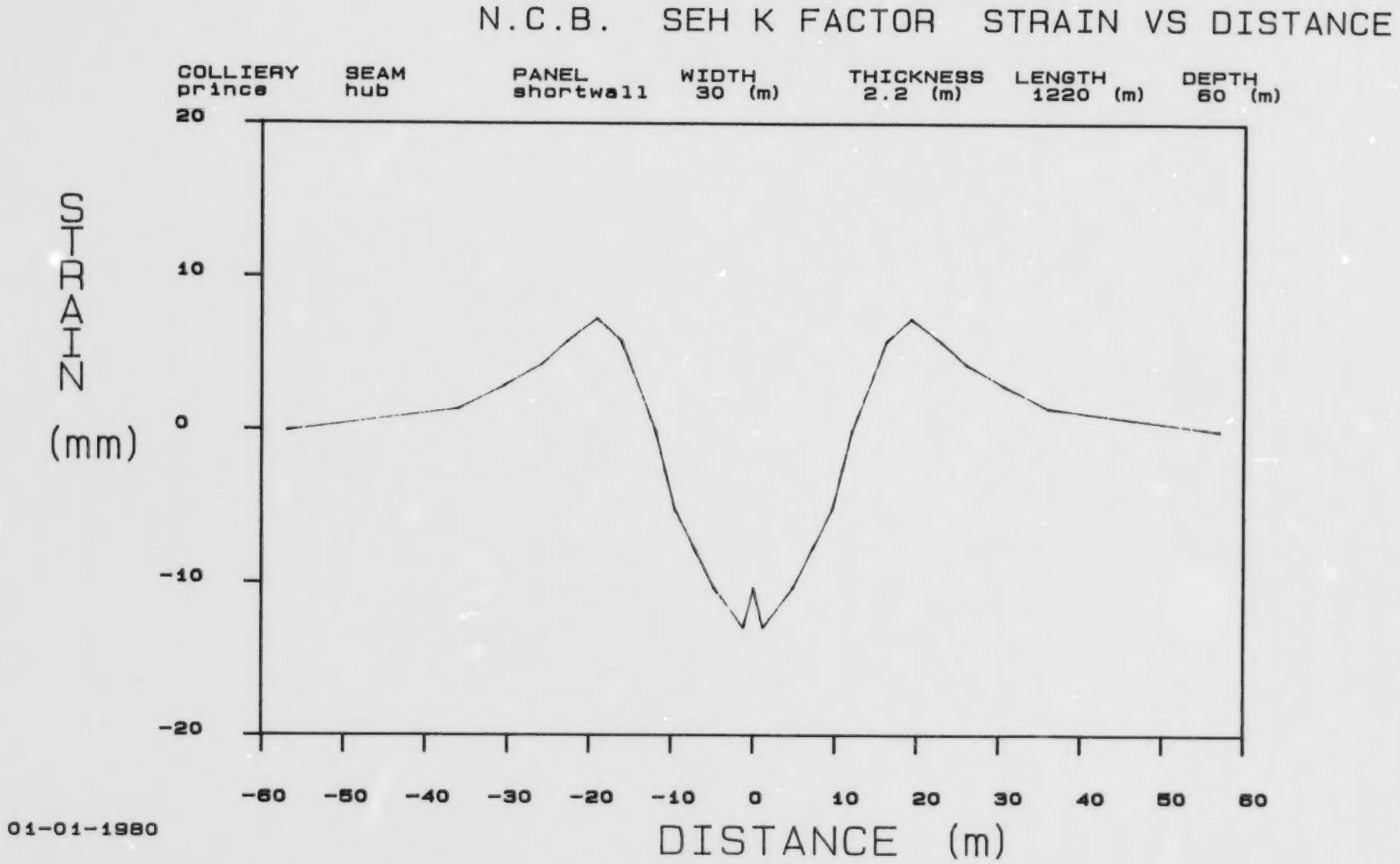

N.C.B. SEH K FACTOR STRAIN VS DISTANCE
COLLIERY prince
SEAM hub
PANEL shortwall
WIDTH 30 (m)
THICKNESS 2.2 (m)
LENGTH 1220 (m)
DEPTH 60 (m)
STRAIN (mm)
20
10
0
-10
-20
-60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60
DISTANCE (m)
01-01-1980

FIGURE A2

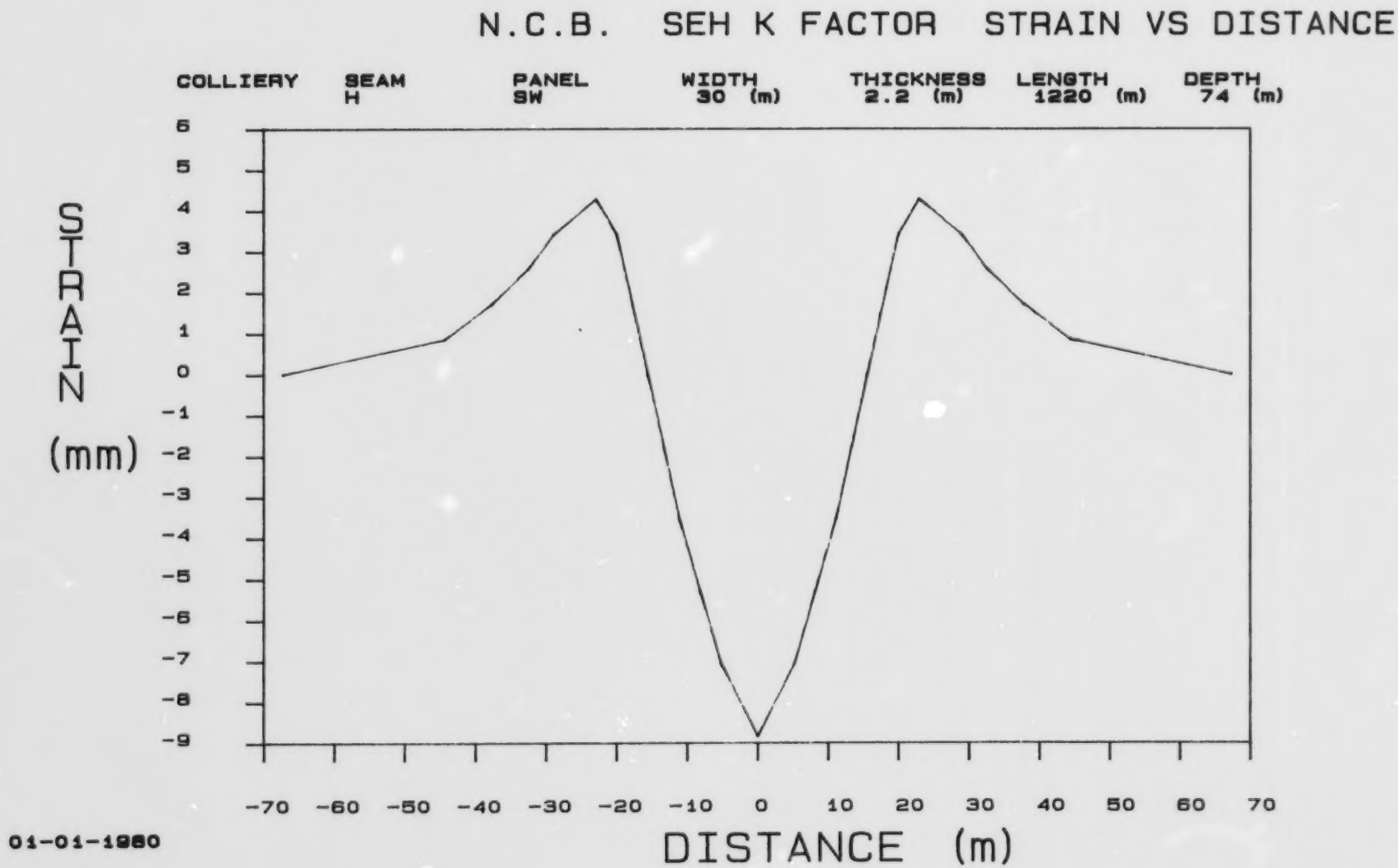

N.C.B. SEH K FACTOR STRAIN VS DISTANCE
COLLIERY
SEAM H
PANEL SW
WIDTH 30 (m)
THICKNESS 2.2 (m)
LENGTH 1220 (m)
DEPTH 74 (m)
STRAIN (mm)
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70
DISTANCE (m)
01-01-1980

FIGURE A3

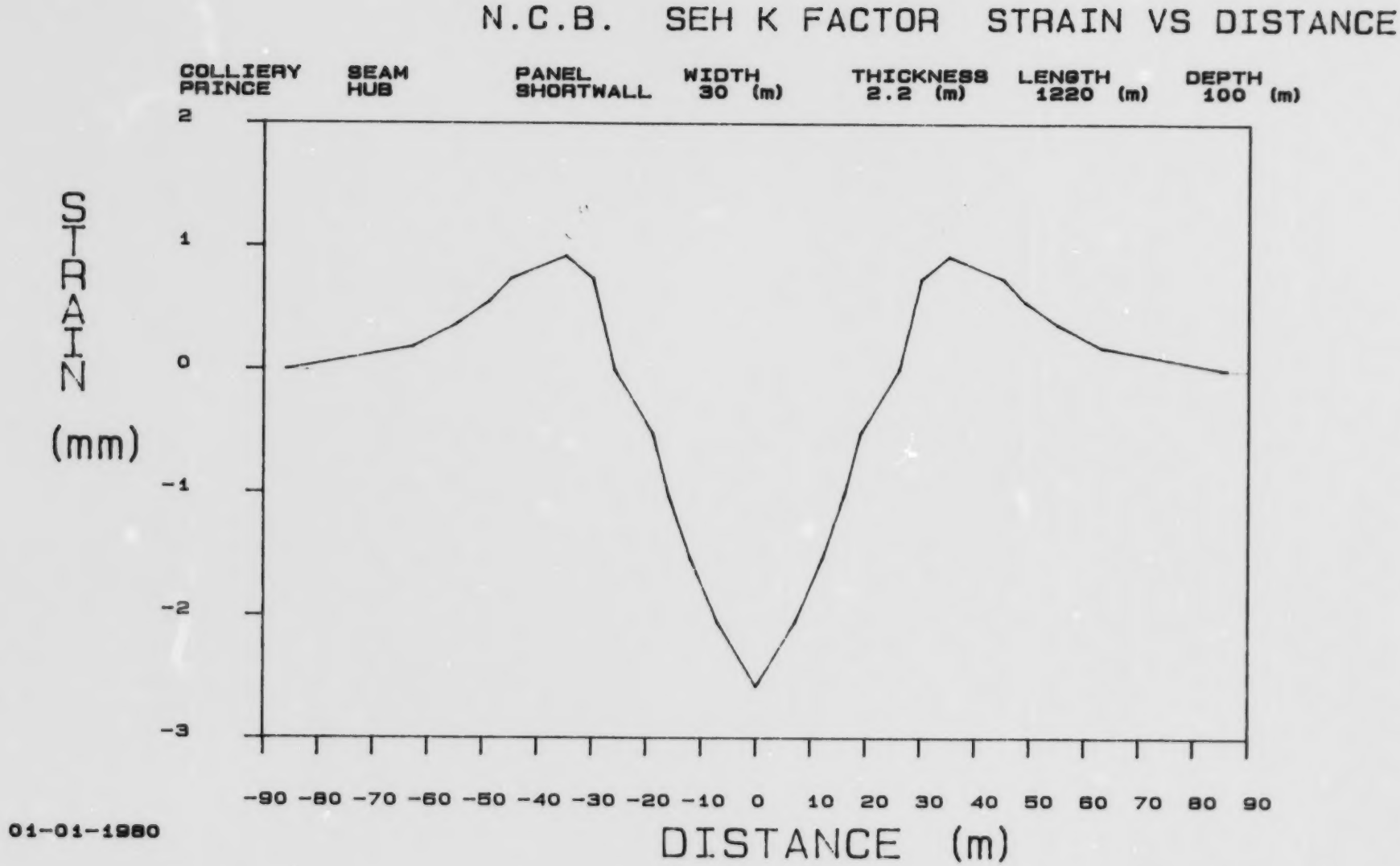

N.C.B. SEH K FACTOR STRAIN VS DISTANCE
COLLIERY PRINCE
SEAM HUB
PANEL SHORTWALL
WIDTH 30 (m)
THICKNESS 2.2 (m)
LENGTH 1220 (m)
DEPTH 100 (m)
STRAIN (mm)
2
1
0
-1
-2
-3
-90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90
DISTANCE (m)
01-01-1980

FIGURE A4

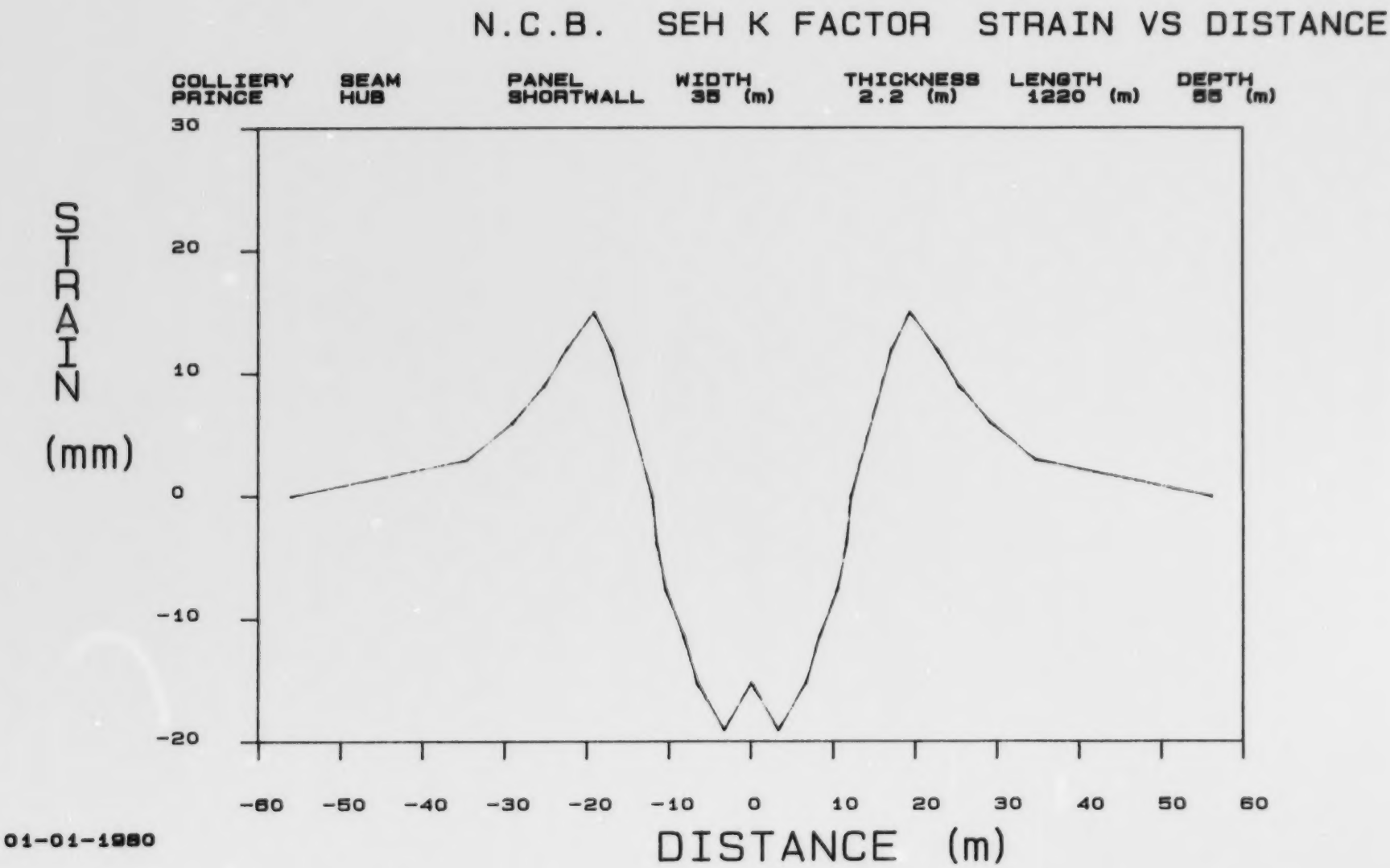

N.C.B. SEH K FACTOR STRAIN VS DISTANCE
COLLIERY PRINCE
SEAM HUB
PANEL SHORTWALL
WIDTH 35 (m)
THICKNESS 2.2 (m)
LENGTH 1220 (m)
DEPTH 55 (m)
STRAIN (mm)
30
20
10
0
-10
-20
-60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60
DISTANCE (m)
01-01-1980

FIGURE A5

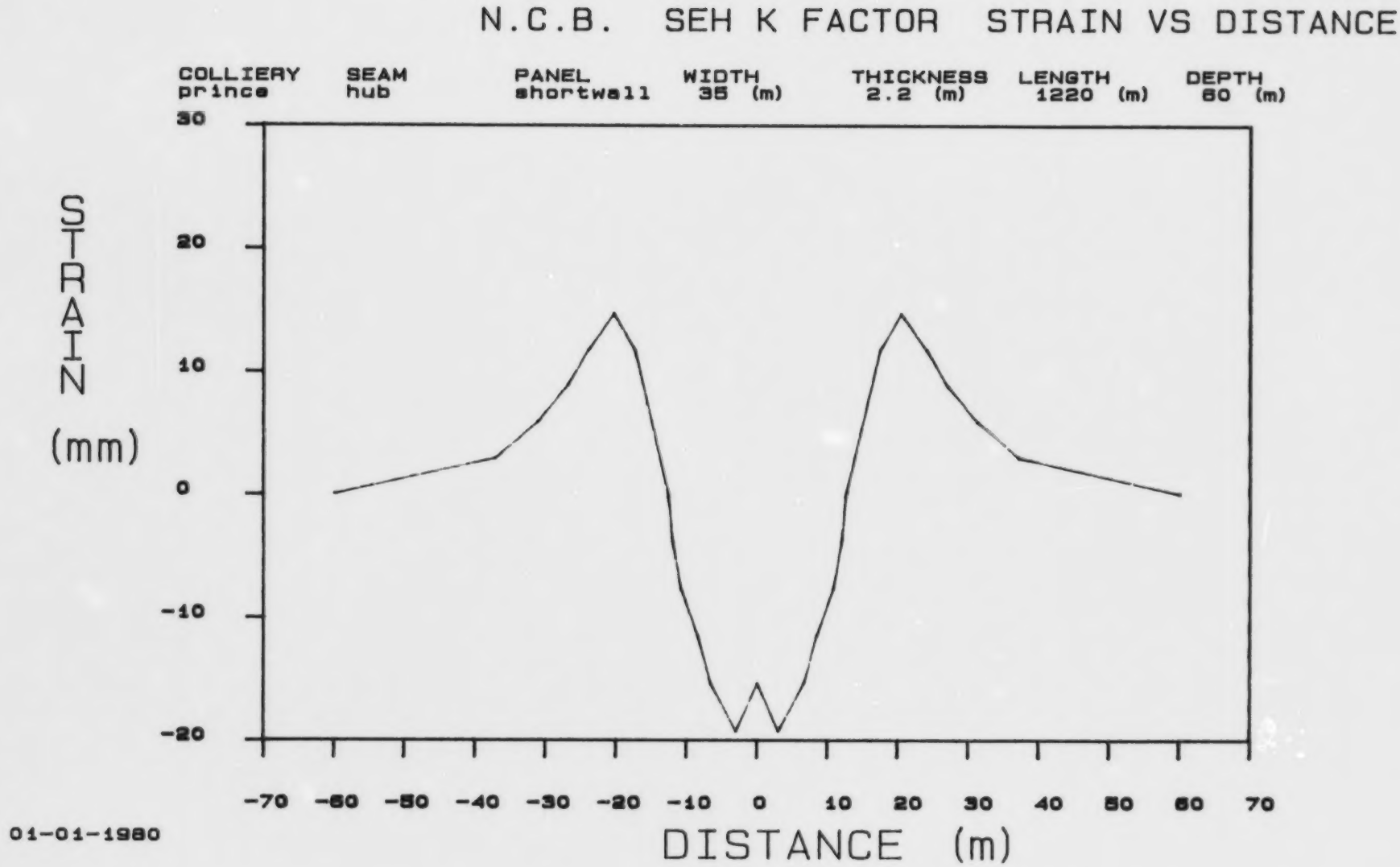

N.C.B. SEH K FACTOR STRAIN VS DISTANCE
COLLIERY prince
SEAM hub
PANEL shortwall
WIDTH 35 (m)
THICKNESS 2.2 (m)
LENGTH 1220 (m)
DEPTH 60 (m)
STRAIN (mm)
30
20
10
0
-10
-20
-70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70
DISTANCE (m)
01-01-1980

FIGURE A6

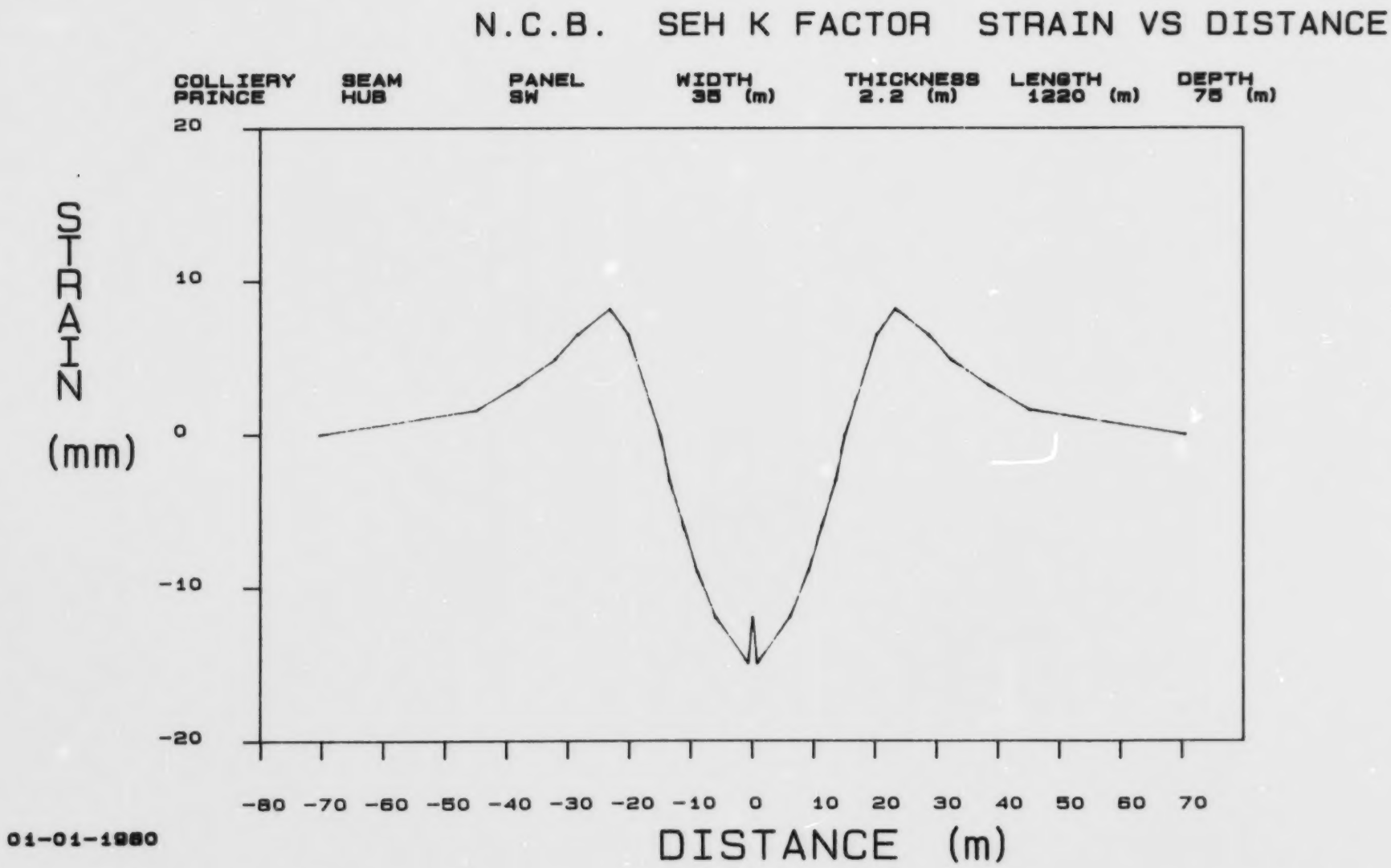

N.C.B. SEH K FACTOR STRAIN VS DISTANCE
COLLIERY PRINCE
SEAM HUB
PANEL SW
WIDTH 35 (m)
THICKNESS 2.2 (m)
LENGTH 1220 (m)
DEPTH 75 (m)
STRAIN (mm)
20
10
0
-10
-20
-80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70
DISTANCE (m)
01-01-1980

FIGURE A7

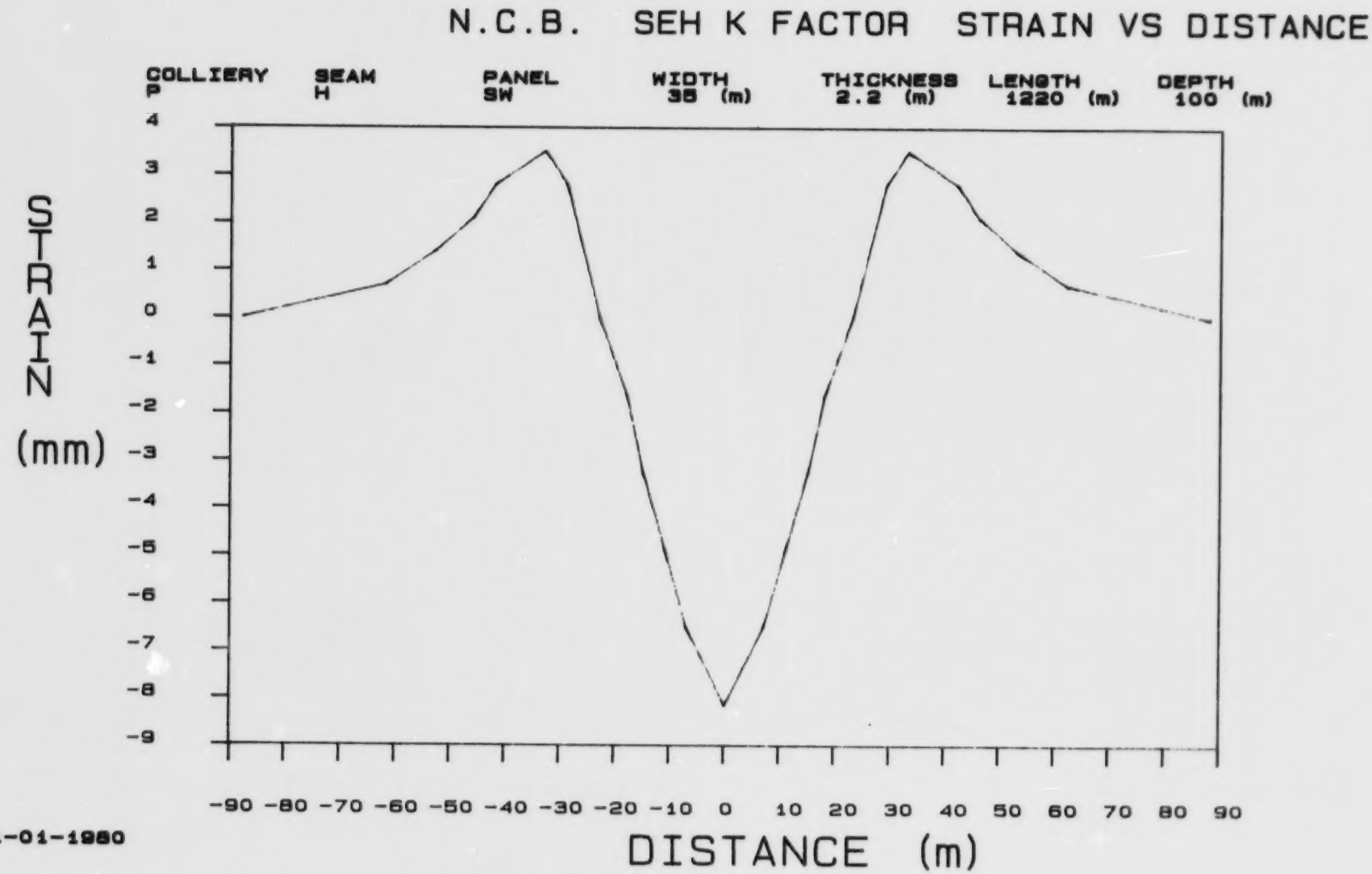

N.C.B. SEH K FACTOR STRAIN VS DISTANCE
COLLIERY P
SEAM H
PANEL SW
WIDTH 35 (m)
THICKNESS 2.2 (m)
LENGTH 1220 (m)
DEPTH 100 (m)
STRAIN (mm)
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90
DISTANCE (m)
01-01-1980

FIGURE A8

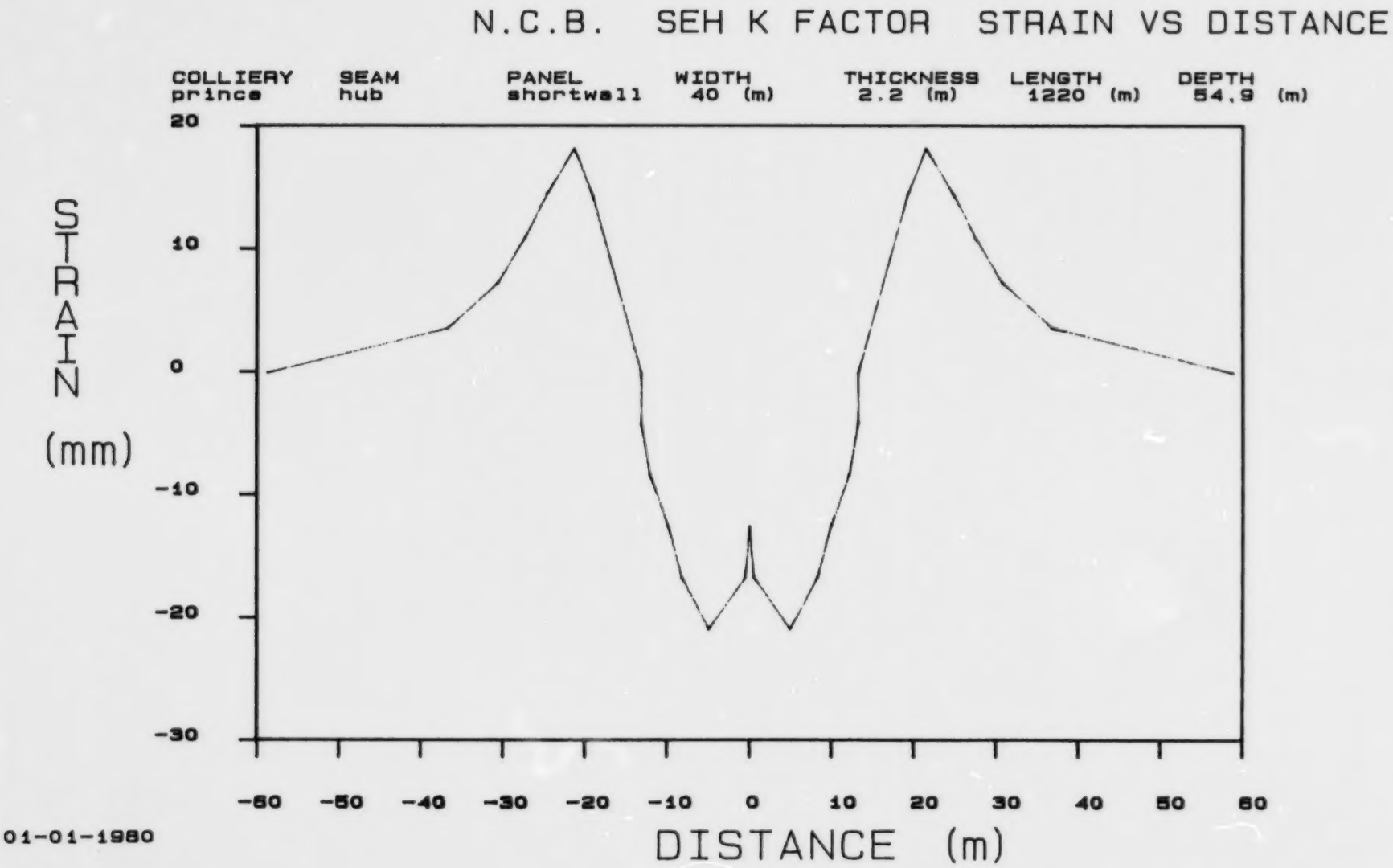

N.C.B. SEH K FACTOR STRAIN VS DISTANCE
COLLIERY prince
SEAM hub
PANEL shortwall
WIDTH 40 (m)
THICKNESS 2.2 (m)
LENGTH 1220 (m)
DEPTH 54.9 (m)
STRAIN (mm)
20
10
0
-10
-20
-30
-60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60
DISTANCE (m)
01-01-1980

FIGURE A9

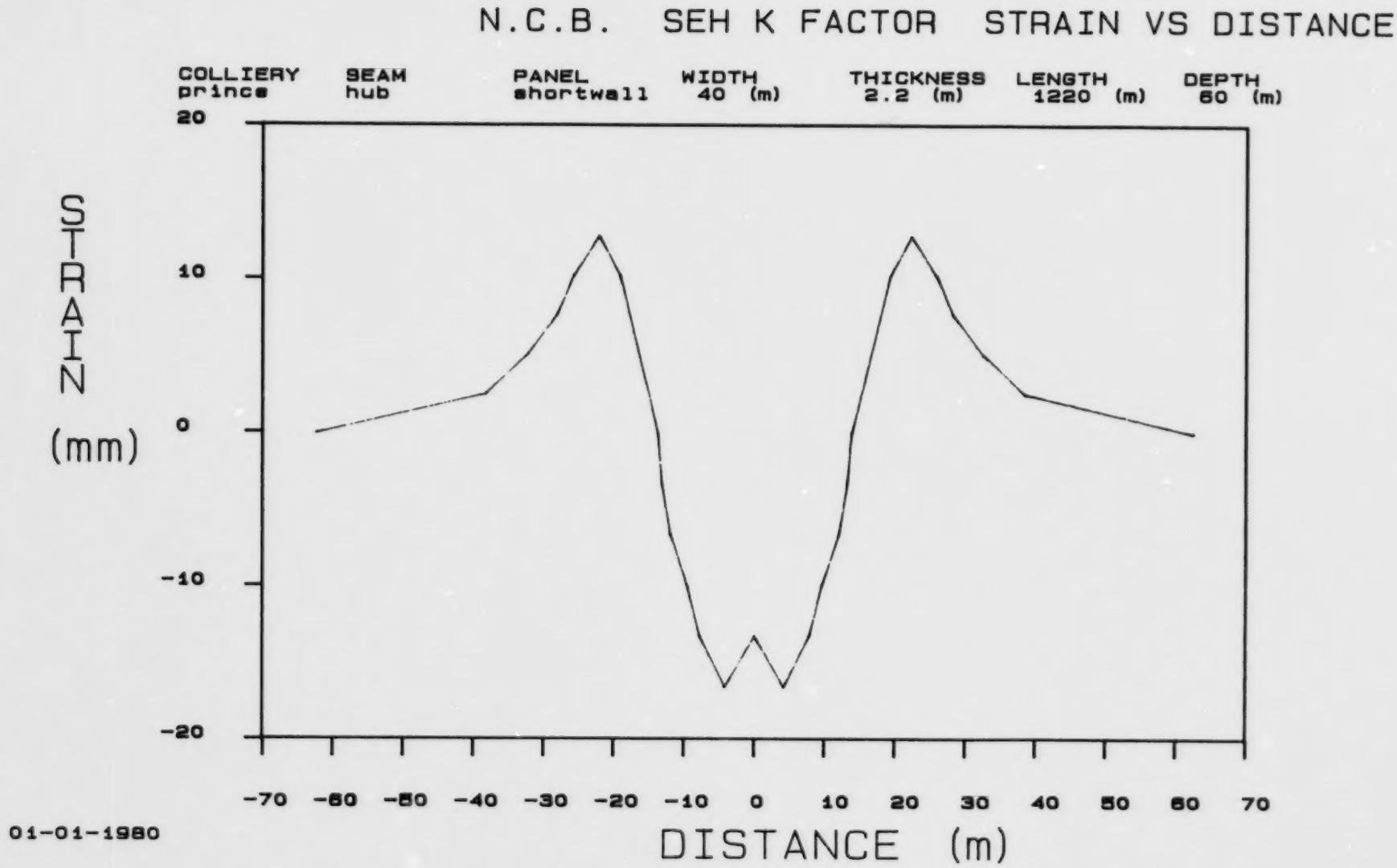

N.C.B. SEH K FACTOR STRAIN VS DISTANCE
COLLIERY prince
SEAM hub
PANEL shortwall
WIDTH 40 (m)
THICKNESS 2.2 (m)
LENGTH 1220 (m)
DEPTH 60 (m)
STRAIN (mm)
20
10
0
-10
-20
-70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70
DISTANCE (m)
01-01-1980

FIGURE A10

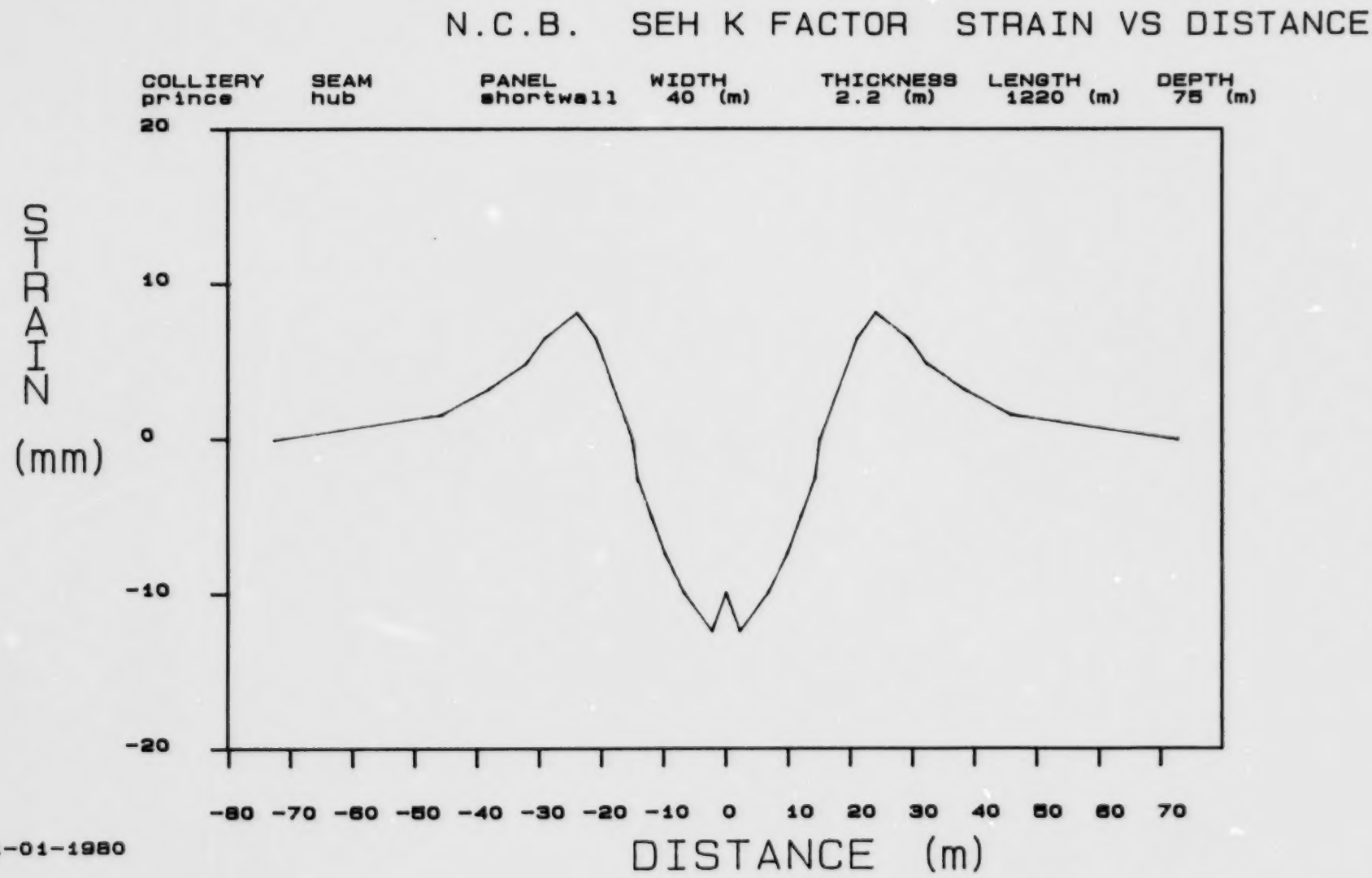

N.C.B. SEH K FACTOR STRAIN VS DISTANCE
COLLIERY prince
SEAM hub
PANEL shortwall
WIDTH 40 (m)
THICKNESS 2.2 (m)
LENGTH 1220 (m)
DEPTH 75 (m)
STRAIN (mm)
20
10
0
-10
-20
-80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70
DISTANCE (m)
01-01-1980

FIGURE AII

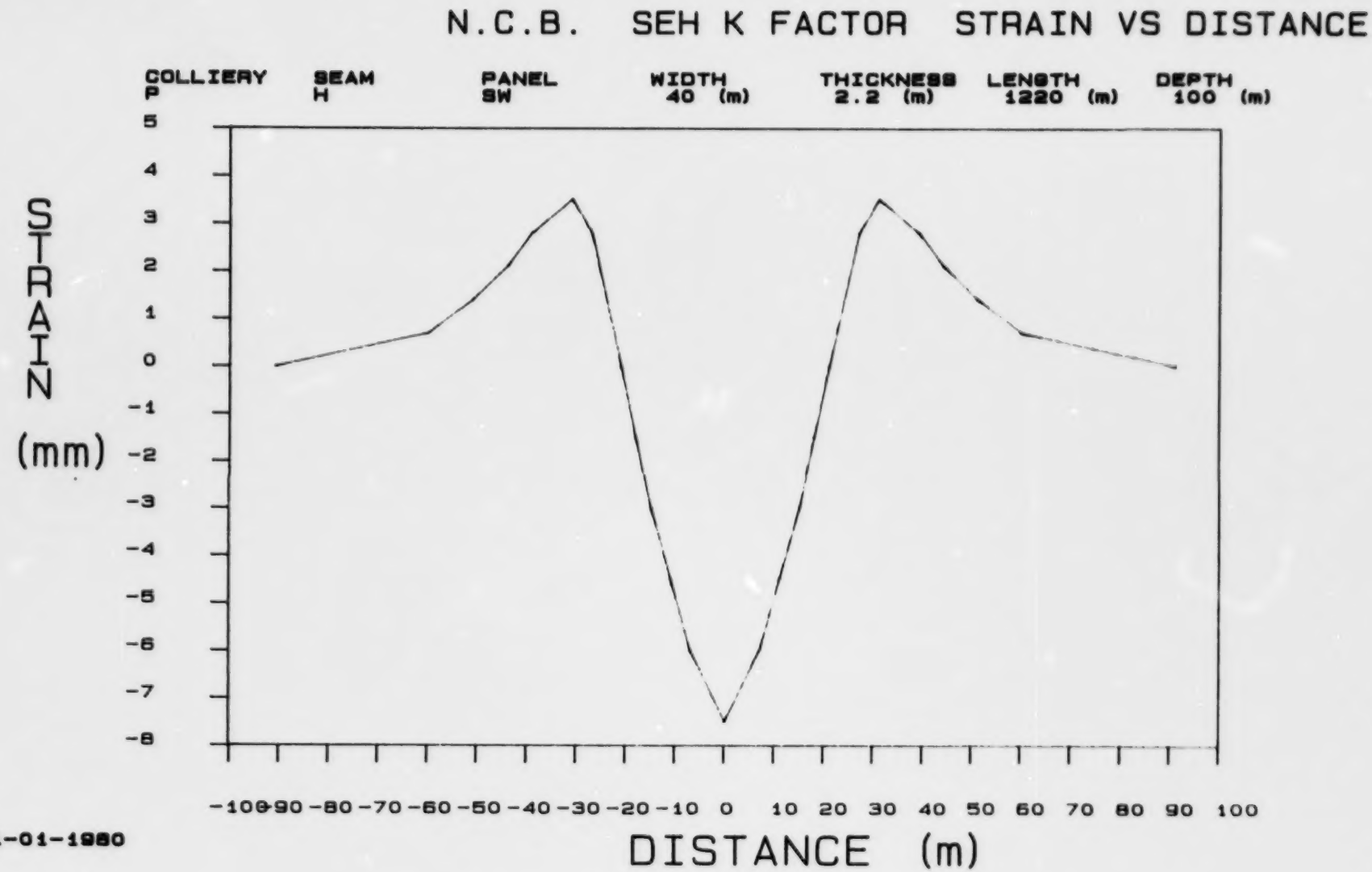

N.C.B. SEH K FACTOR STRAIN VS DISTANCE
COLLIERY P
SEAM H
PANEL SW
WIDTH 40 (m)
THICKNESS 2.2 (m)
LENGTH 1220 (m)
DEPTH 100 (m)
STRAIN (mm)
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-100 -90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100
DISTANCE (m)
01-01-1980

FIGURE A12

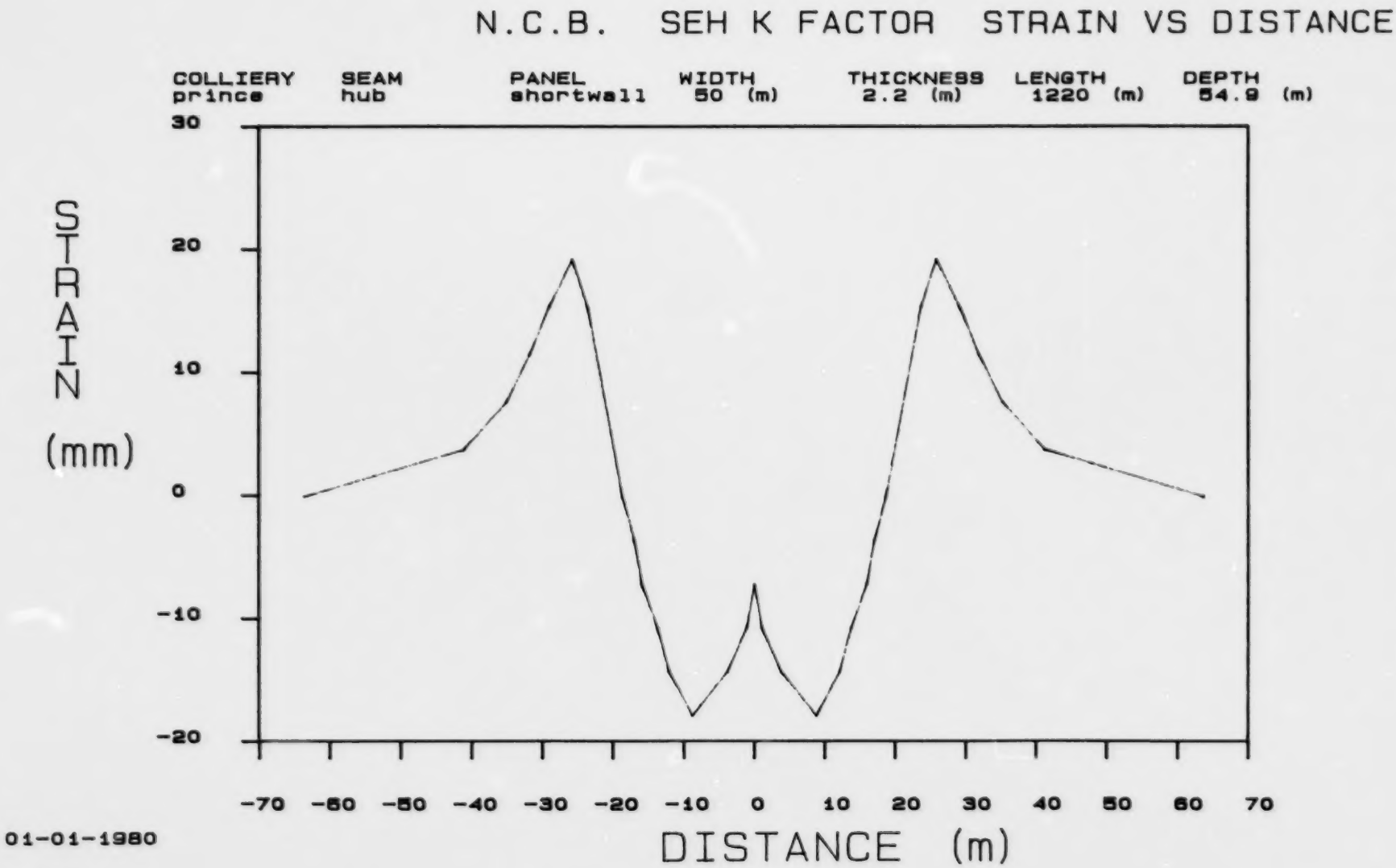

N.C.B. SEH K FACTOR STRAIN VS DISTANCE
COLLIERY prince
SEAM hub
PANEL shortwall
WIDTH 50 (m)
THICKNESS 2.2 (m)
LENGTH 1220 (m)
DEPTH 54.9 (m)
STRAIN (mm)
30
20
10
0
-10
-20
-70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70
DISTANCE (m)
01-01-1980

FIGURE A 13

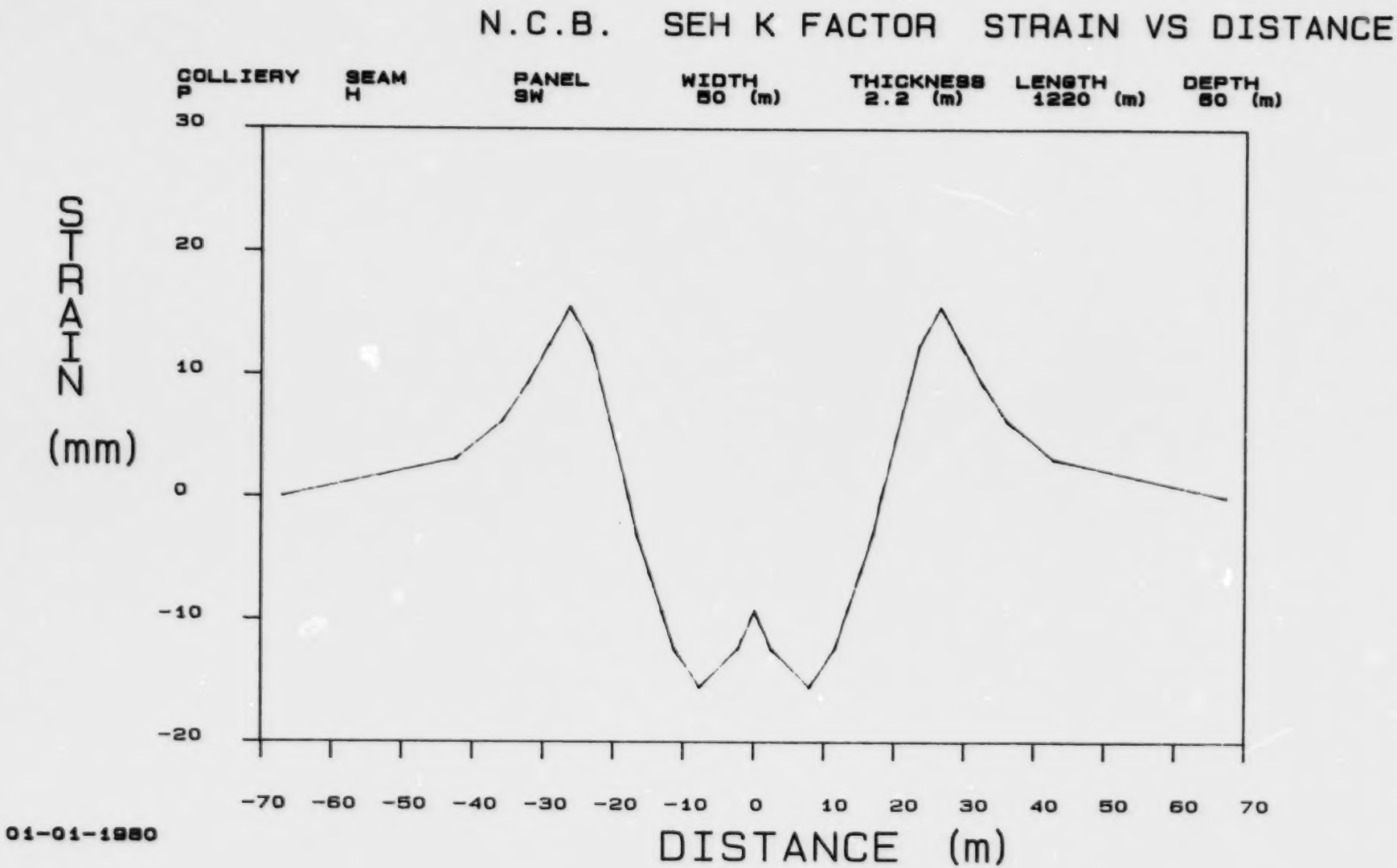

N.C.B. SEH K FACTOR STRAIN VS DISTANCE
COLLIERY P
SEAM H
PANEL SW
WIDTH 50 (m)
THICKNESS 2.2 (m)
LENGTH 1220 (m)
DEPTH 50 (m)
STRAIN (mm)
30
20
10
0
-10
-20
-70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70
DISTANCE (m)
01-01-1980

FIGURE A14

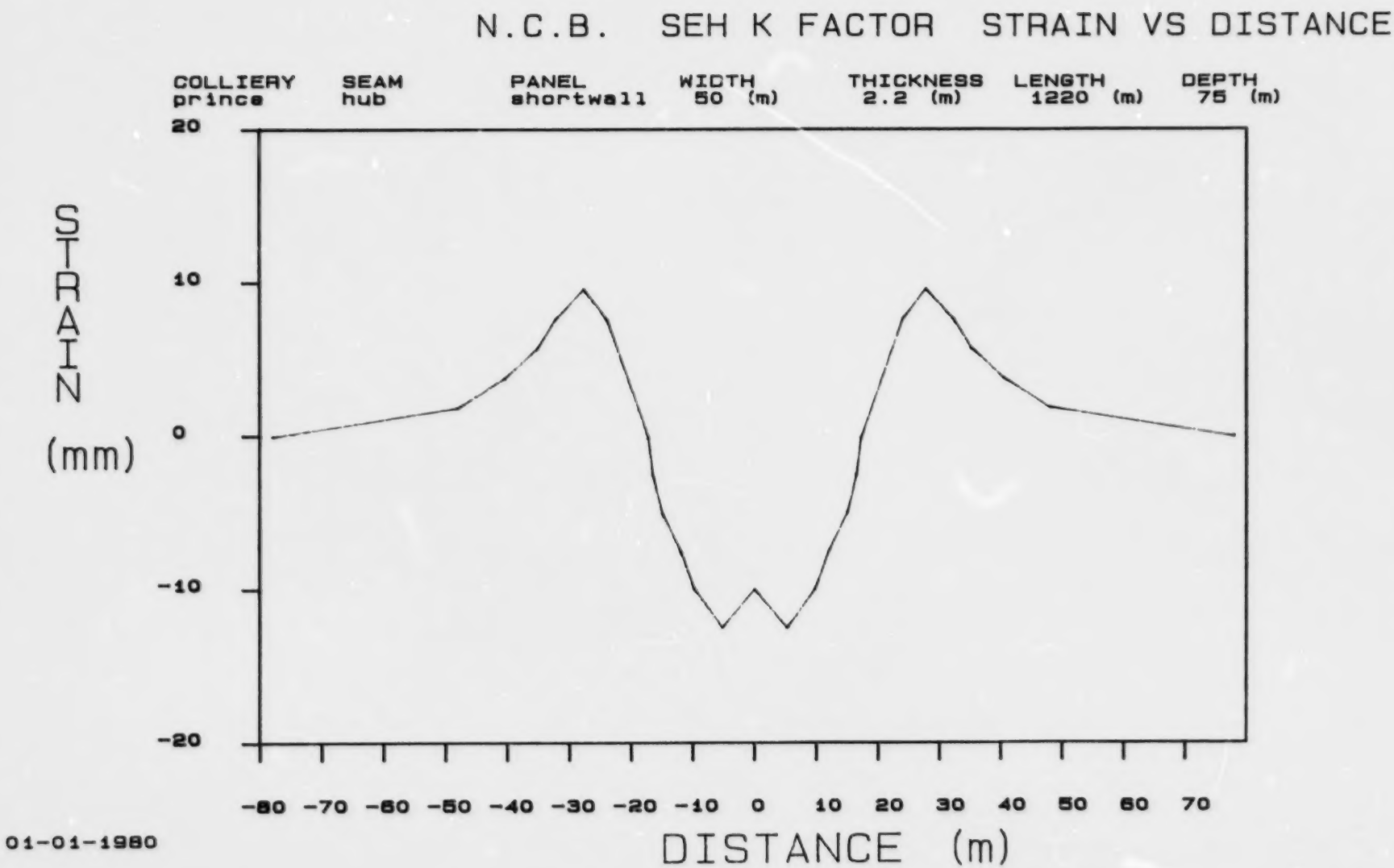

N.C.B. SEH K FACTOR STRAIN VS DISTANCE
COLLIERY prince
SEAM hub
PANEL shortwall
WIDTH 50 (m)
THICKNESS 2.2 (m)
LENGTH 1220 (m)
DEPTH 75 (m)
STRAIN (mm)
20
10
0
-10
-20
-80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70
DISTANCE (m)
01-01-1980

FIGURE A15

APPENDIX A2

Prediction of Pillar Stress

Expressions used in calculating distributions of vertical stress at rib sides (after Wilson 1981).

	Weak seam between strong roof and floor	Roof, seam and floor of similar strength
vertical stress	$\sigma_{zz} = bp^* \exp\left(\frac{xF}{m}\right)$	$\sigma_{zz} = bp^* \left(\frac{2x}{m} + 1\right)^{b-1}$
peak abutment or yield stress	$\sigma_y = C_0 + bp$	$\sigma_y = C_0 + bp$
width of yield zone	$x_b = \frac{m}{F} \ln \left(\frac{p}{p^*}\right)$	$x_b = \frac{m}{2}\left[\left(\frac{p}{p^*}\right)^{1/(b-1)} - 1\right]$
vertical force carried by the yield zone	$A_b = \frac{m}{F} b(p - p^*)$	$A_b = \frac{m}{2} p^* \left[\left(\frac{p}{p^*}\right)^{b/(b-1)} - 1\right]$

σ_{zz} = vertical stress;
σ_y = peak abutment or yield stress;
$p = \gamma h$ = vertical stress remote from the excavation;
C_0 = *in-situ* uniaxial compressive strength of the strata;
b = constant in the principal stress form of the Coulomb shear strength equation, $\sigma_1 = C_0 + b\sigma_3$;
m = height of the extraction;

x = distance from the rib side;
x_b = width of yield zone;
p^* = support pressure, p_i, plus the unconfined compressive strength of the broken material at the rib side, taken as 0.1 MPa, i.e. $p^* = p_i + 0.1$ MPa;

$F = \frac{b-1}{\sqrt{b}} \left(1 + \frac{b-1}{\sqrt{b}} \tan^{-1} \sqrt{b}\right)$, where $\tan^{-1} \sqrt{b}$ is expressed in radians.

The stress in the zone beyond the peak stress decays asymptotically towards the overburden stress, p. The stress decay curve is assumed to be of the form

$$(\sigma_{zz} - p) = (\sigma_y - p) \exp\left(\frac{x_b - x}{C}\right)$$

where C is a constant having the units of distance. By equating areas under the curves in Figure 15.4c so as to maintain a vertical stress balance, the value of C is calculated as

$$C = \frac{A_w + px_b - A_b}{\sigma_y - p}$$

where A_w is the 'load deficiency' associated with each rib side as shown in Figures 15.4a and 15.4b.

For $w > 0.6h$,

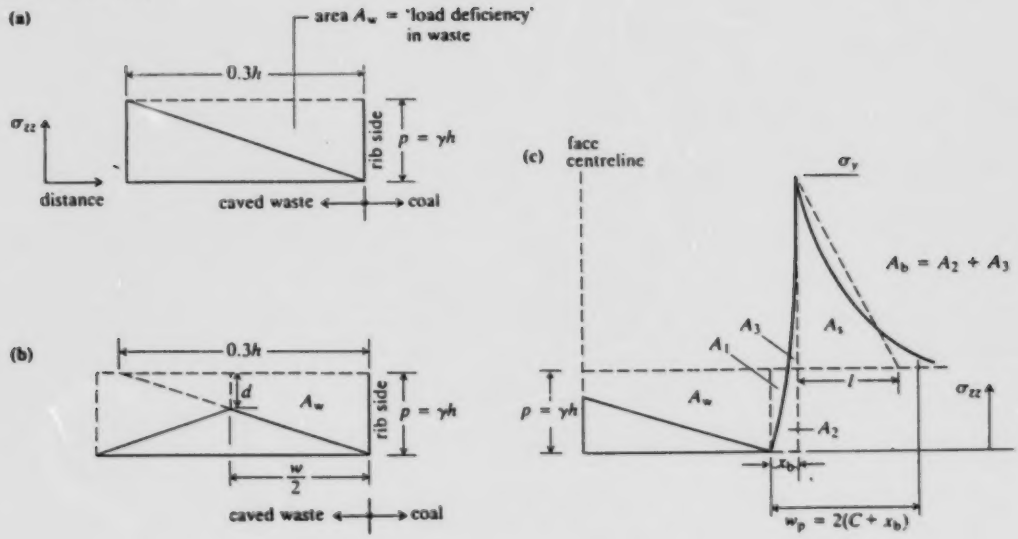
$$A_w = 0.15\gamma h^2$$

and for $w < 0.6h$,

$$A_w = \tfrac{1}{2} w\gamma \left(h - \frac{w}{1.2}\right)$$

where w is the width of the extracted area.

. Idealised distribution of vertical stress, σ_{zz}, in the caved waste for (a) face length, $w > 0.6h$, and (b) $w < 0.6\,h$; (c) stress area balance across the rib side (after Wilson 1981).



Material Properties

C_o = 5 MPa ~ ie UCS = 20 MPa/4 ← rock mass strength reduction factor

m = 2.2 m

b = (1 + sin Ø)/ (1 - sin Ø) = 4

APPENDIX A3

Determination of Design Parameters for Roof Bolting in Coal Mines

Determination of design parameters for roof-bolting in coal mines

Design charts have been developed (Unal, 1983) for mechanical and resin grouted bolts for application in U.S. coal mines. The following equations are used for calculations:

Mechanical bolts

1. Rock-load height:

$$h_t = \left[\frac{100 - \mathrm{RMR}}{100}\right] B$$

2. Bolt length (assumed that the bolt anchor is in the compression zone for suspension effect):

$$L_b = \frac{h_t}{2}$$

where

h_t is the rock-load height;
B is the roof span;
RMR is the rock mass rating for the Geomechanics Classification.

3. Bolt capacity (determined from pull-out tests in the field):

$C_b = L_y$ or L_f whichever is smaller

where

L_y = yield-load of steel;
L_f = anchorage failure-load.

4. Bolt spacing (includes a safety factor of 1.5 corresponding to a reduction of the anchorage capacity by 67%, equivalent to bolt tension $T = C_b/1.5$, to meet mining regulations):

$$S_b = \frac{C_b}{1.5\gamma h_t}$$

Resin bolts

1. Rock-load height:

$$h_t = \left[\frac{100 - \mathrm{RMR}}{100}\right] B$$

2. Bolt length = resin length:

$$L_r = \sqrt{\frac{\gamma B^2 h_t}{2\sigma_h}} \quad \text{or} \quad \sqrt{\frac{B^2 h_t}{300}}$$

where σ_h is the horizontal stress acting on the roof arch and γ is the unit weight of the rock. The lower limit of the lateral stress necessary for maintaining a roof arch is assumed to be 1.15 MPa (167 psi) for a depth of 150 m (500 ft) corresponding to one-third of the vertical stress. For $\gamma = 25.1\ \text{kN/m}^3$ ($160\ \text{lb/ft}^3$) the simplified expression is obtained.

3. Bolt capacity and spacing: As for mechanical bolts.

Bolts and posts

Total rock pressure (rock-load):

$$P_t = \gamma h_t$$

Pressure on posts:

$$P_p = \gamma h_p$$

Pressure on bolts:

$$P_b = \gamma h_b$$

Rock-load capacity by posts:

$$C_p^* = \frac{C_p}{A_p}$$

where

C_p is load capacity of each post (tons);
A_p is the area supported by each post.

Rock-load height carried by bolts:

$$h_b = \frac{\gamma h_t - C_p^*}{\gamma}$$

Design charts

A series of design charts (Unal, 1983) for entries and intersections is available, as depicted.

A. Classification parameters and their ratings

PARAMETER			RANGES OF VALUES						
1	Strength of intact rock material	Point-load strength index	> 10 MPa	4 - 10 MPa	2 - 4 MPa	1 - 2 MPa	For this low range - uniaxial compressive test is preferred		
		Uniaxial compressive strength	>250 MPa	100 - 250 MPa	50 - 100 MPa	25 - 50 MPa	5-25 MPa	1-5 MPa	< 1 MPa
	Rating		15	12	7	4	2	1	0
2	Drill core quality RQD		90% - 100%	75% - 90%	50% - 75%	25% - 50%	< 25%		
	Rating		20	17	13	8	3		
3	Spacing of discontinuities		>2 m	0.6 - 2 m	200 - 600 mm	60 -200 mm	< 60 mm		
	Rating		20	15	10	8	5		
4	Condition of discontinuities		Very rough surfaces. Not continuous No seperation Unweathered wall rock.	Slightly rough surfaces. Separation < 1 mm Slightly weathered walls	Slightly rough surfaces. Separation < 1 mm Highly weathered walls	Slickensided surfaces OR Gouge < 5 mm thick OR Separation 1-5 mm. Continuous	Soft gouge > 5 mm thick OR Separation > 5 mm. Continous		
	Rating		30	25	20	10	0		
5	Ground water	Inflow per 10 m tunnel length	None	<10 litres/min	10-25 litres/min	25 - 125 litres/min	> 125		
		Ratio $\frac{\text{joint water pressure}}{\text{major principal stress}}$	OR 0	OR 0.0-0.1	OR 0.1-0.2	OR 0.2-0.5	OR > 0.5		
		General conditions	OR Completely dry	OR Damp	OR Wet	OR Dripping	OR Flowing		
	Rating		15	10	7	4	0		

APPENDIX B

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REFERENCES

Ref #

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APPENDIX C

SELECTED EQUIPMENT BROCHURES

HEADING AND FACE DRIVAGE MACHINES

- WESTFALIA VME
- EICKHOFF ESA
- DOSCO IN-SEAM MINER

SHORT SINGLE ENDED RANGING DRUM SHEARERS

- BJD ACE
- ANDERSON STRATHCLYDE AM500

CURVED AFC

- HALBACH & BRAUN
- WULTEX - BECORIT

MODULAR IN-SEAM BELT CONVEYOR

- FLETCHER SUTCLIFFE WILD

POWERED SUPPORTS

- HEMSCHEIDT
- GULLICK DOBSON
- GD ELECTROFLEX SYSTEM
- DOWTY ELECTRONIC CONTROL SYSTEM

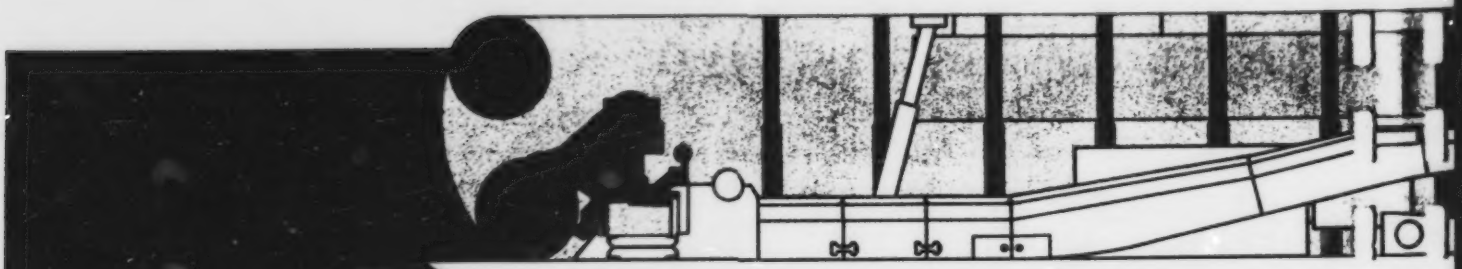
MATERIALS TRANSPORT

- EIMCO

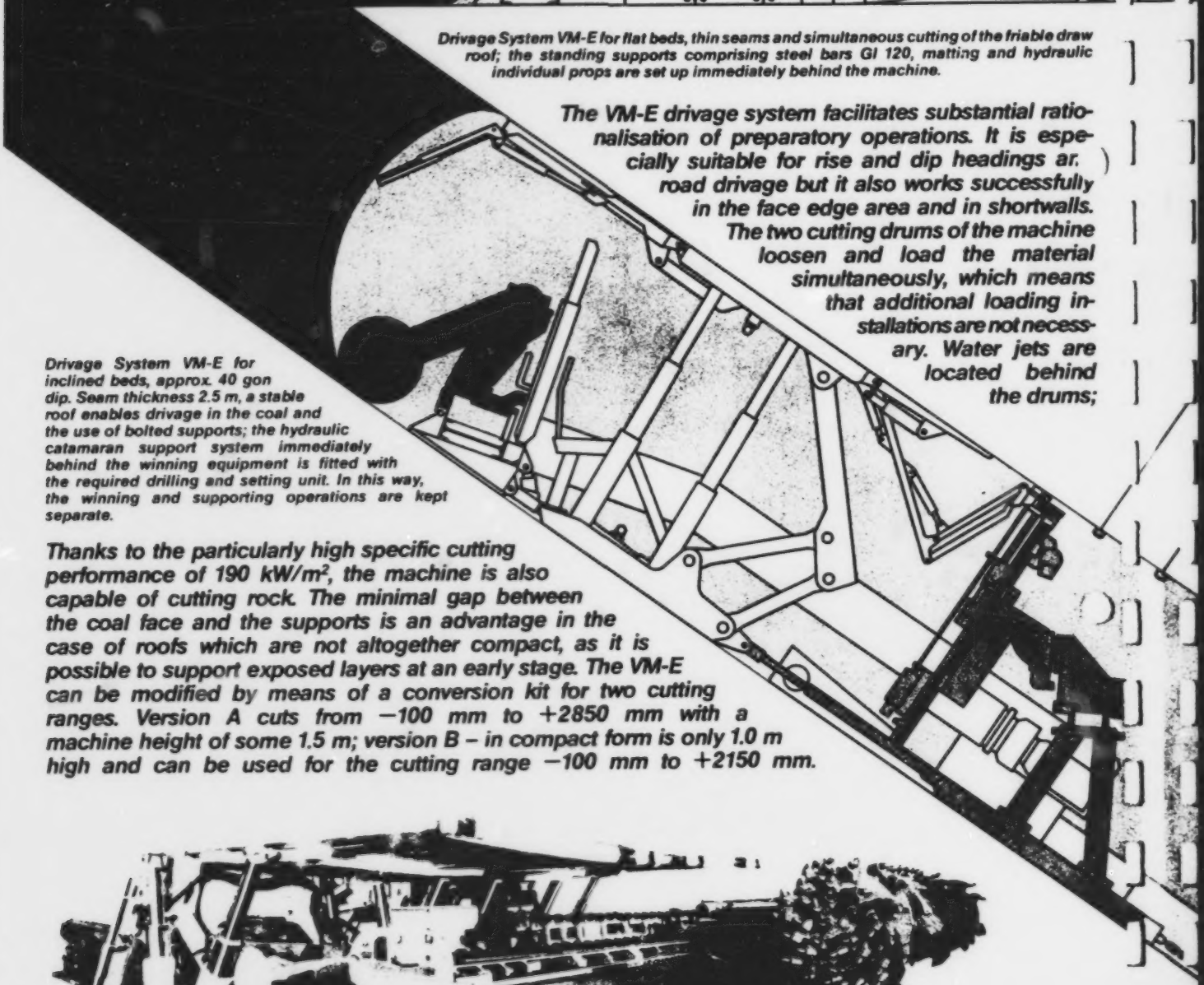
WESTFALIA LÜNEN

Preparatory Work

Competitive



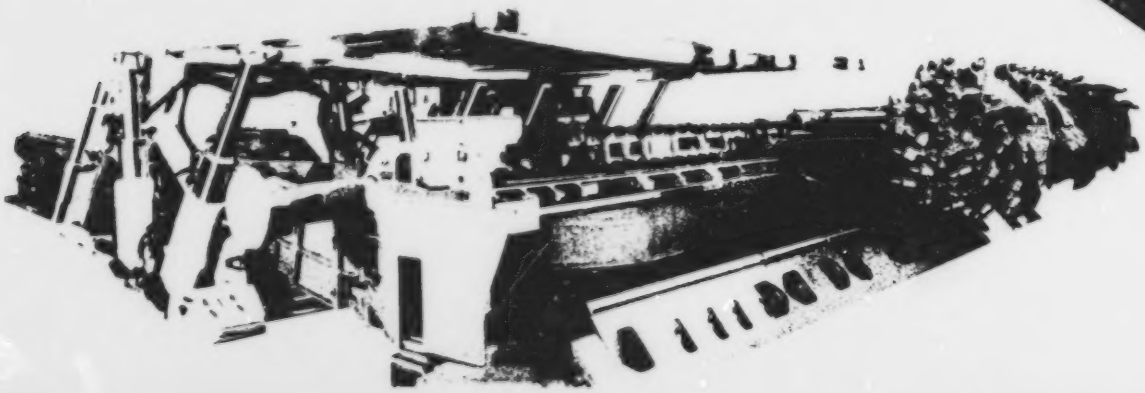
Drivage System VM-E for flat beds, thin seams and simultaneous cutting of the friable draw roof; the standing supports comprising steel bars GI 120, matting and hydraulic individual props are set up immediately behind the machine.



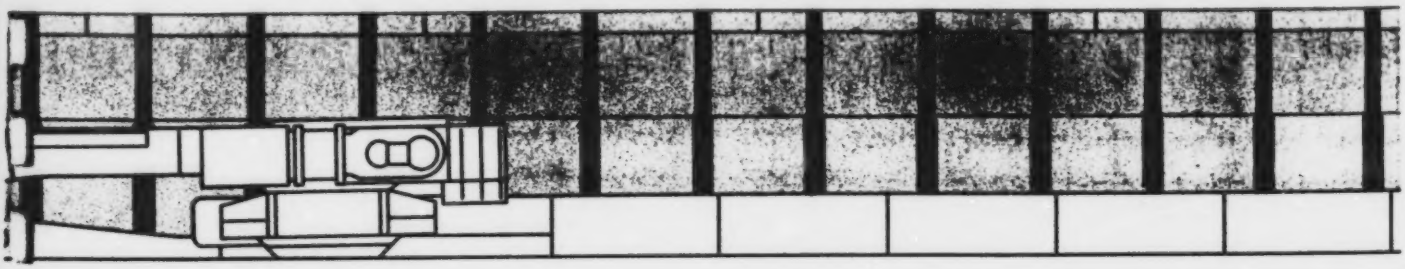
The VM-E drivage system facilitates substantial rationalisation of preparatory operations. It is especially suitable for rise and dip headings ar. road drivage but it also works successfully in the face edge area and in shortwalls. The two cutting drums of the machine loosen and load the material simultaneously, which means that additional loading installations are not necessary. Water jets are located behind the drums;

Drivage System VM-E for inclined beds, approx. 40 gon dip. Seam thickness 2.5 m, a stable roof enables drivage in the coal and the use of bolted supports; the hydraulic catamaran support system immediately behind the winning equipment is fitted with the required drilling and setting unit. In this way, the winning and supporting operations are kept separate.

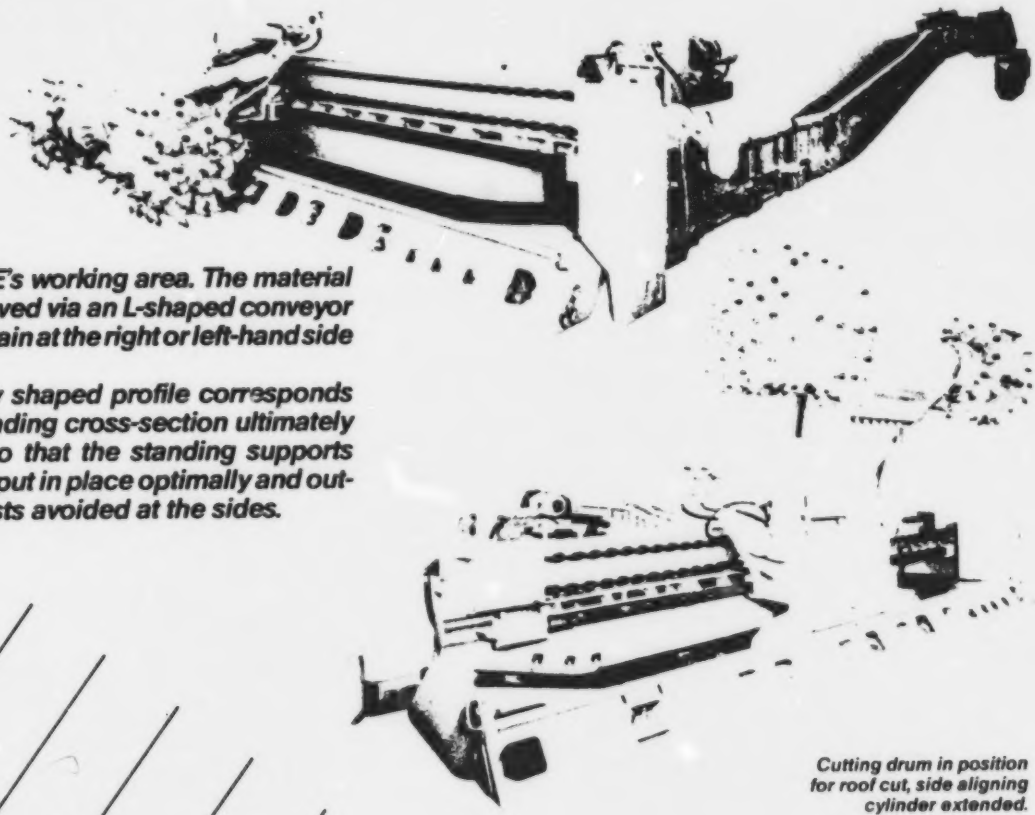
Thanks to the particularly high specific cutting performance of 190 kW/m², the machine is also capable of cutting rock. The minimal gap between the coal face and the supports is an advantage in the case of roofs which are not altogether compact, as it is possible to support exposed layers at an early stage. The VM-E can be modified by means of a conversion kit for two cutting ranges. Version A cuts from −100 mm to +2850 mm with a machine height of some 1.5 m; version B – in compact form is only 1.0 m high and can be used for the cutting range −100 mm to +2150 mm.



Shortwalling

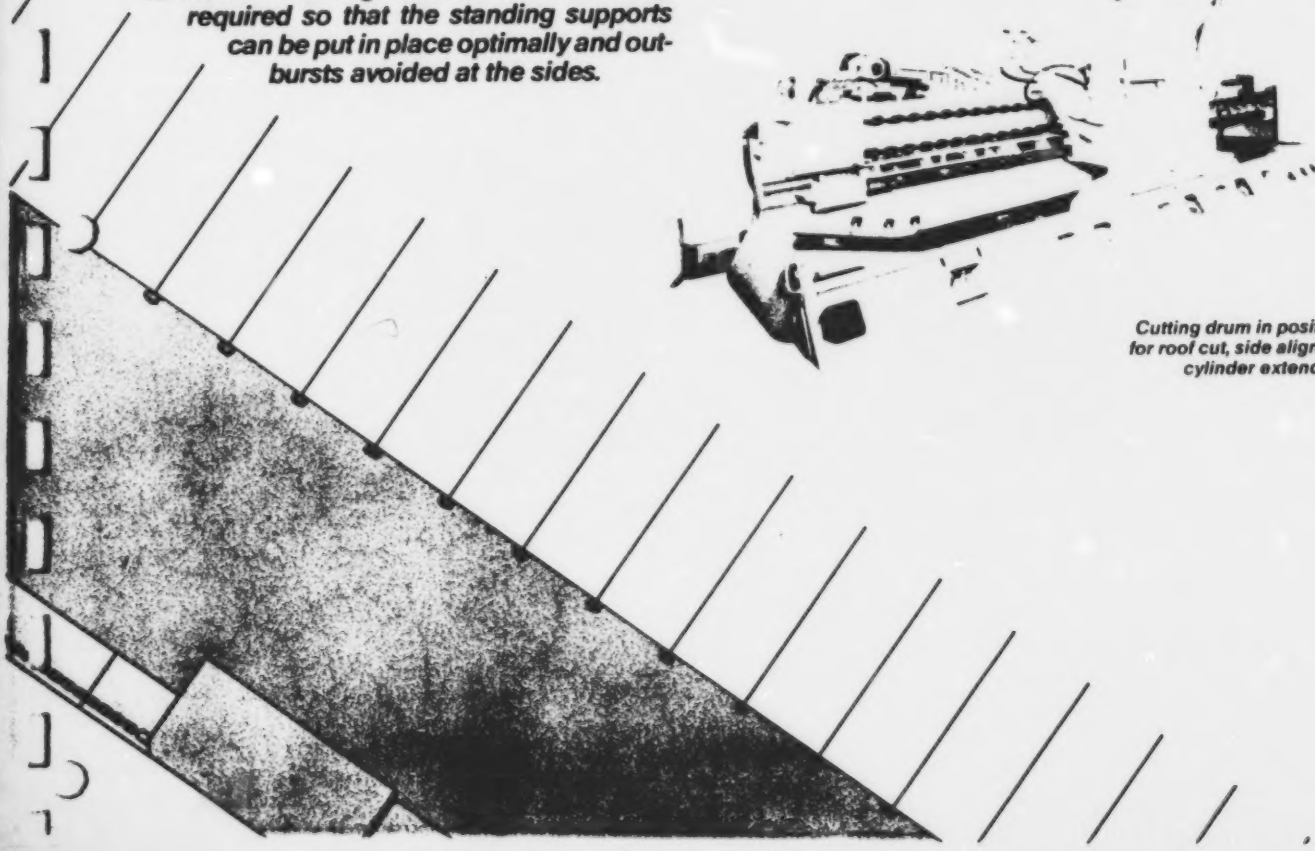


VM-E with L-conveyor on its left-hand side, cutting drum position for floor cut.



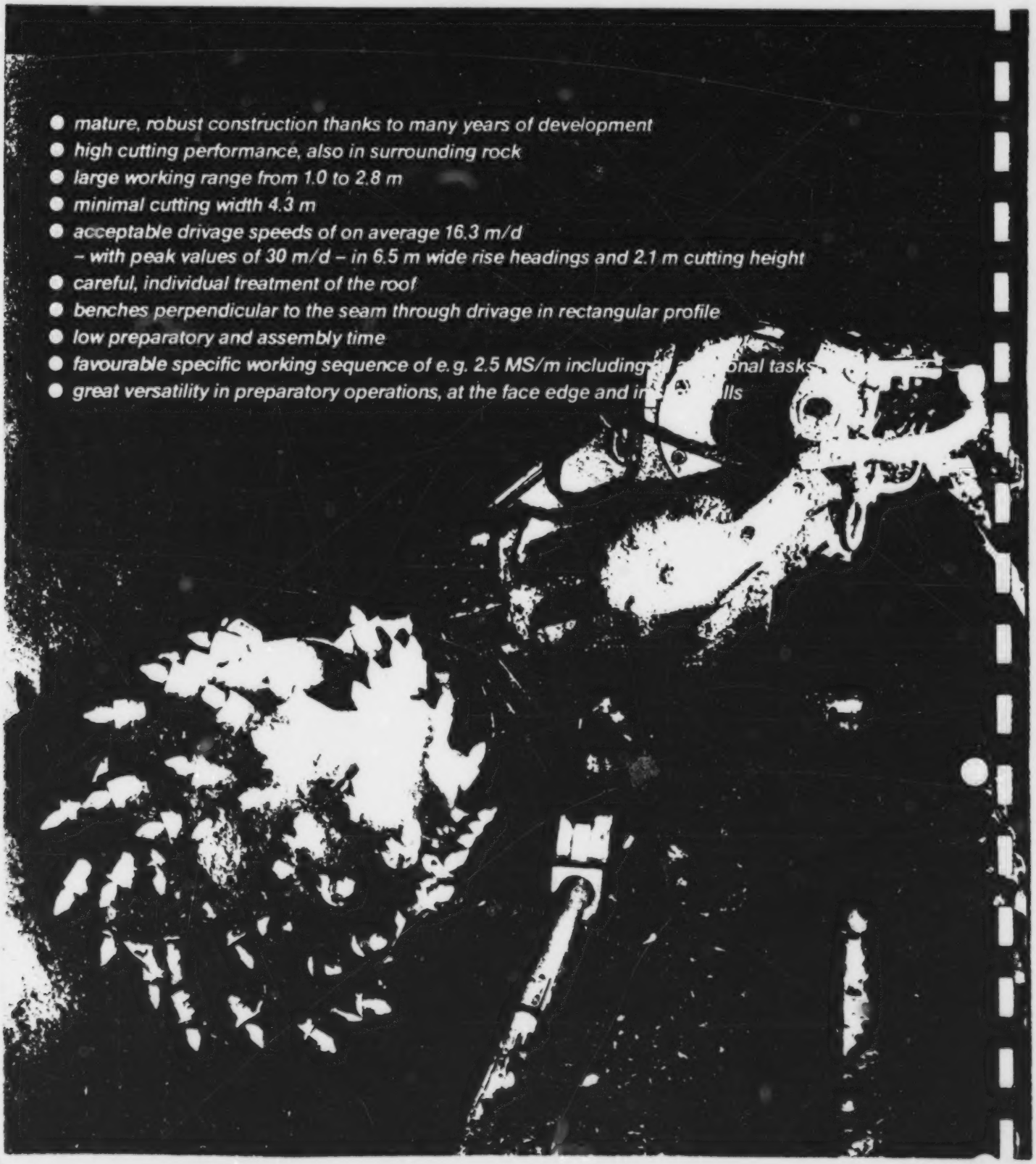
these spray the VM-E's working area. The material which is won is removed via an L-shaped conveyor with central strand chain at the right or left-hand side as desired.

The rectangularly shaped profile corresponds to the rise heading cross-section ultimately required so that the standing supports can be put in place optimally and outbursts avoided at the sides.



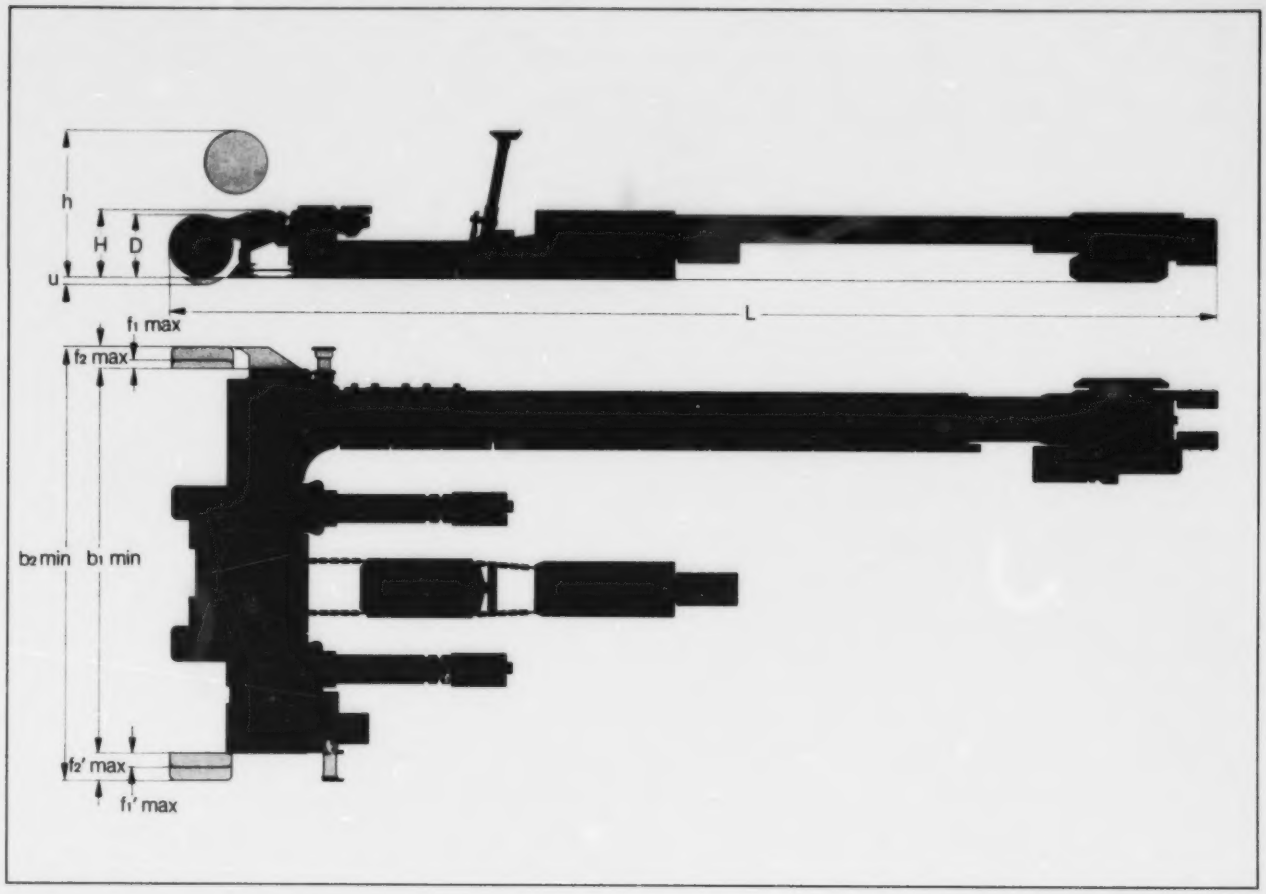
Cutting drum in position for roof cut, side aligning cylinder extended.

VM-E represents



- *mature, robust construction thanks to many years of development*
- *high cutting performance, also in surrounding rock*
- *large working range from 1.0 to 2.8 m*
- *minimal cutting width 4.3 m*
- *acceptable drivage speeds of on average 16.3 m/d*
  – with peak values of 30 m/d – in 6.5 m wide rise headings and 2.1 m cutting height
- *careful, individual treatment of the roof*
- *benches perpendicular to the seam through drivage in rectangular profile*
- *low preparatory and assembly time*
- *favourable specific working sequence of e.g. 2.5 MS/m including [illegible]onal tasks*
- *great versatility in preparatory operations, at the face edge and in [illegible]lls*

VM-E Heading and Mining System with hydraulic shifting devices and anchorage props



Main dimensions and operating range of the machine

h – 2150/2850 mm
u – 100 mm
H – 1000/1500 mm
D – 900 mm
L – 8 to 30 m

b_1 min – 4300 mm with 510 mm wide cutting heads
b_2 min – 4700 mm with 710 mm wide cutting heads
f_1 max. – 120 mm
f_2 max. – 320 mm
f_1' max. – 230 mm
f_2' max. – 430 mm

The VM-E system is designed for cutting headings and entries, and for mining residual pillars, and the like. It mainly comprises the actual cutting machine and the conveyor – arranged in an L-form – with 90° curved pan. The conveyor provides the base on which the cutting machine rides. The length of the conveyor part extended along the coalface and of the discharging conveyor part can be varied to suit the individual application. Currently the VM-E is available in two versions differing in the overall machine height. For a conversion, only a bracket, a boom, and two lifting cylinders are required.

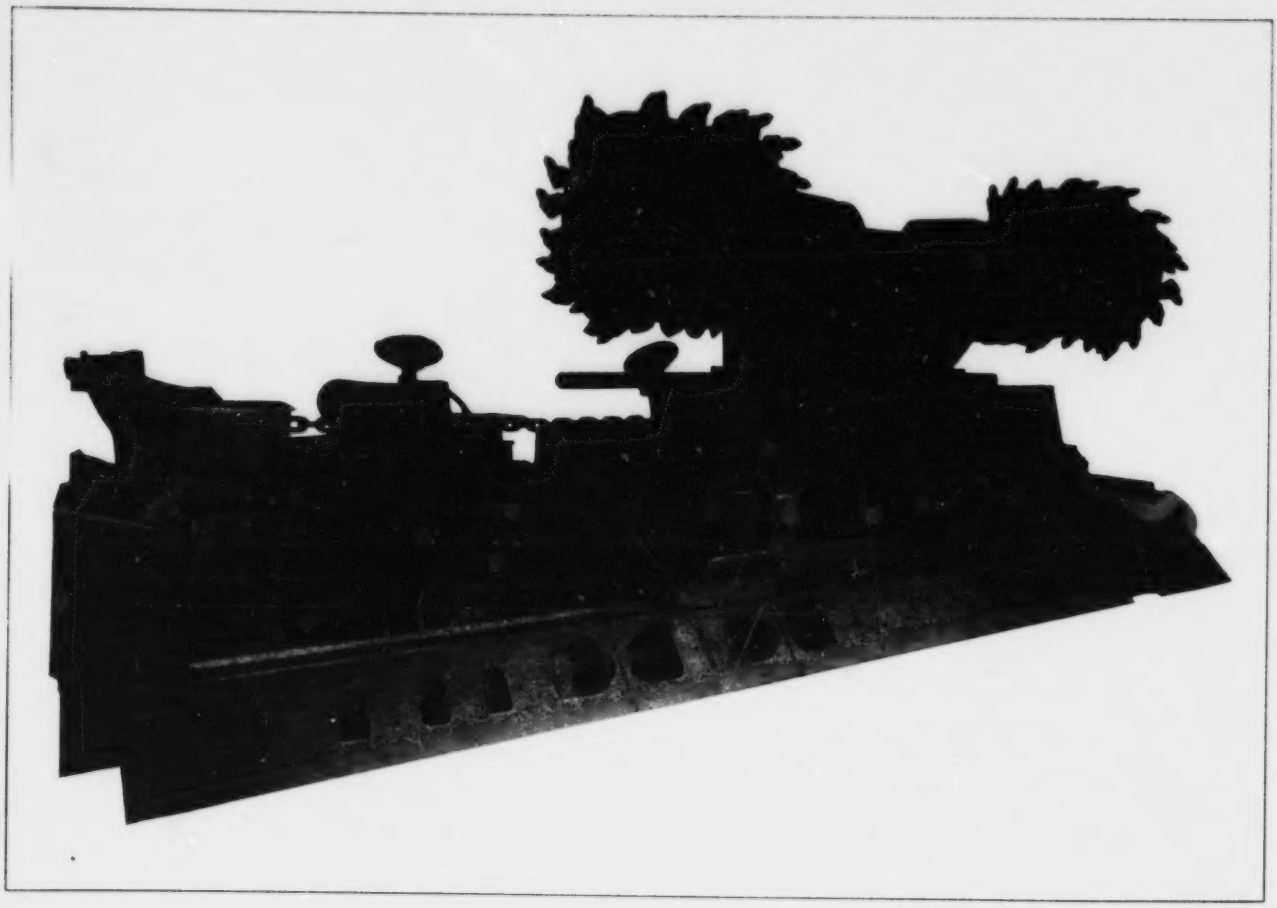
A chain haulage system pulls the cutting machine along the conveyor. The captive-guided underframe carries the ranging arm with its two cutting heads. The ranging arm consists of the boom, the cutting head motor and planetary gearboxes. The cutting heads are equipped with replaceable, front and peripheral picks and load the mined material onto the conveyor. The haulage system is powered by a continuously variable hydraulic drive. Hydraulic shifting rams push the machine forward towards the face. Steering devices at the end pans and the curved pan permit to maintain the direction of advance. The mining machine is supplied with a water-spraying system.

Power packs are taken along for the hydraulic supply.

The VM-E is easy to assemble. To facilitate handling and transportation the machine dismantles into conveniently sized components.

Ltd. Nr. 34 Sa/e - SVVV - RTR - 823 Subject to alteration

VM-E Heading and Mining System with hydraulic shifting devices and anchorage props



Technical Data:

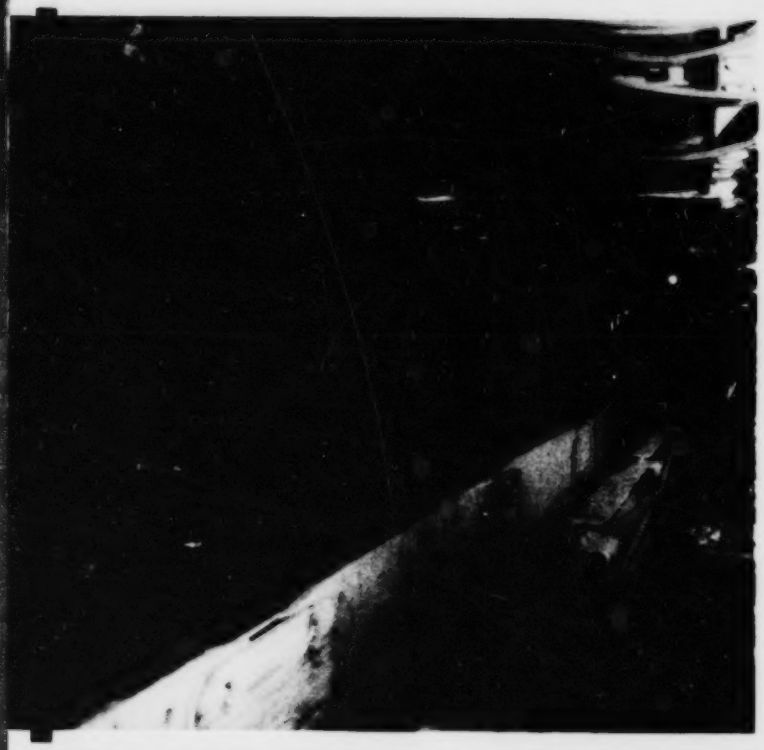
Electric motor for cutting head	120 kW
Power pack motor [1])	63 kW
Degree of protection	(Sch) d, e; IP 44/54
Pressure fluid for haulage system	HFC
Tank capacity	1000 l
Haulage force	120 kN
Travel speed	0 – 22 m/min.
Conveyor	Length and power rating acc. to operating conditions
Conveyor capacity	300 – 400 t/h

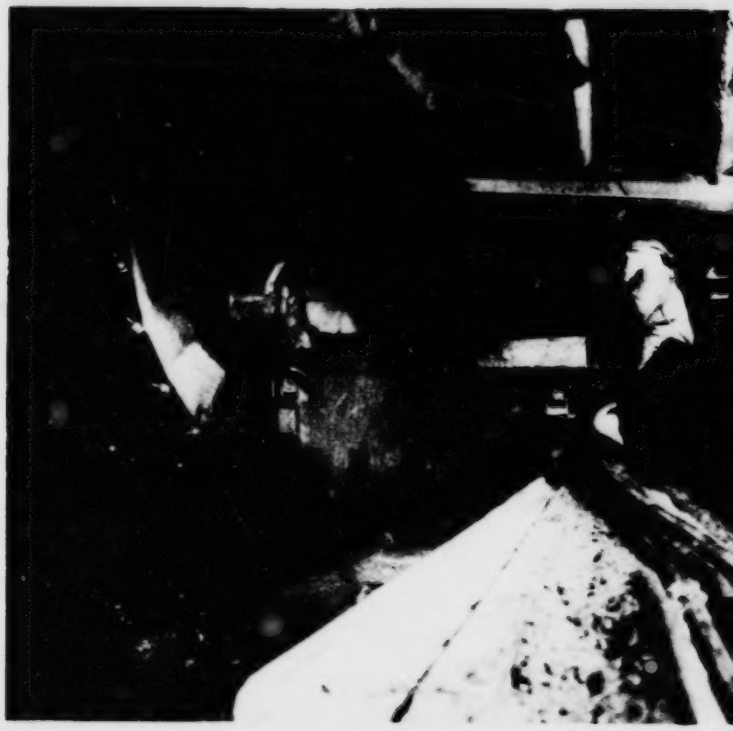
The machine cuts minerals up to a compressive strength of 4 000 N/cm². Even harder strata may be cut economically, depending upon the stratification and tenacity of the mineral.

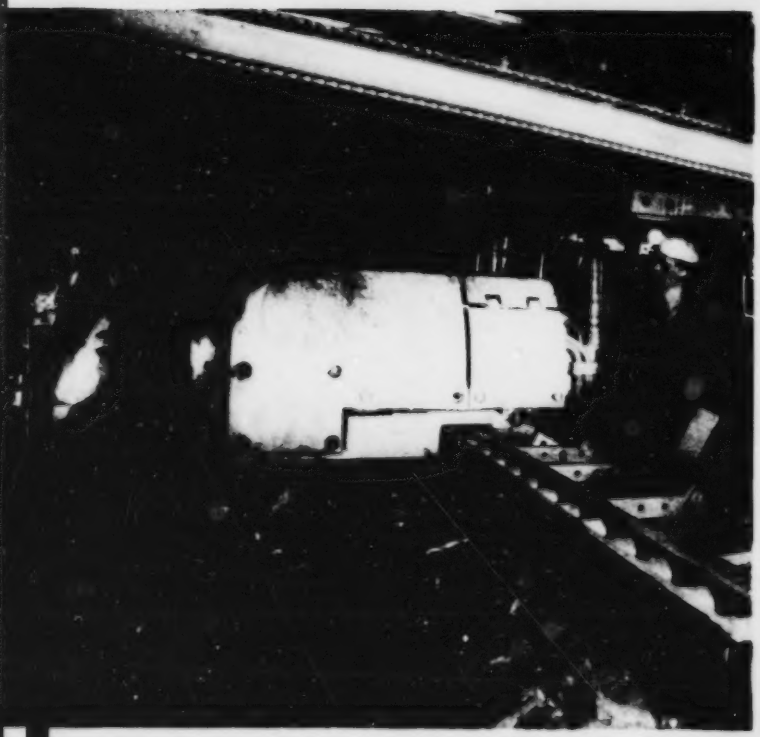
[1]) Power to the hydraulic cylinders is supplied by the hydraulic system of the face. A power pack with a higher capacity for the supply of the haulage and hydraulic cylinders with HFC pressure fluid is available as optional item.

Eickhoff-Walzenlader und ESA-Maschinen

Eickhoff Shearer Loaders and ESA Mining Machines







Eickhoff-Walzenlader und ESA-Maschinen Baukastenprinzip und Einsatzmöglichkeiten

Walzenlader mit Mittelmotor

Shearer Loaders with Central Motor

	Baureihe 170 L 170 L Series	Baureihe 200 L 200 L Series	Baureihe 300 L 300 L Series	Baureihe 300 LN 300 LN Series	Baureihe 380 L 380 L Series	Baureihe 450 L 450 L Series
	Hydraulische Winde/ Hydraulic haulage box			Elektrische Winde		
Einfach Walzenlader Single ended ranging drum shearer	EW-170-L 1,4–3 m 1100–1400 mm	EW-200-L 1,6–3,5 m	EW-300-L (-LH) 1,8–5,5 m		EW-380-L 1,35–3,6 m 1050–1400 mm	
Doppel Walzenlader Einmotoren Ausführung Double ended ranging drum shearer Single motor version	EDW-170-L 1,4–3 m 1100–1400 mm	EDW-200-L 1,6–3,5 m	EDW-300-L (-LH) 1,8–5,5 m		EDW-380-L 1,35–3,6 m 1050–1400 mm	EDW-450-L
Doppel Walzenlader Zweimotoren Ausführung Double ended ranging drum shearer Two motor version	EDW-170/340-L 1,4–3 m 1100–1400 mm	EDW-200/400-L 1,6–3,5 m	EDW-300/600-L (-LH) 1,8–5,5 m		EDW-380/760-L 1,35–3,6 m 1050–1400 mm	EDW-450/1000-L
Doppel Walzenlader Liegend-maschine Double ended ranging drum shearer Floor based machine	EDW-170-LN 0,75–1,7 m 605–800 mm	EDW-200-LN 1,2–1,7 m 700–900 mm		EDW-300-LN 0,8–1,7 m 600–900 mm		
Weiteres Motorgrößen können verwandt werden	200 kW 60 Hz	230 kW 50 Hz 230 kW 60 Hz	350 kW 60 Hz 380 kW 50 u. 60 Hz 380 kW 3,3 bis 5 kV			500 kW 3,3 bis 5 kV
Other sizes available	200 kW 60 Hz	230 kW 50 Hz 230 kW 60 Hz	350 kW 60 Hz 380 kW 50 u. 60 Hz 380 kW 3,3 up to 5 kV			500 kW 3,3 up to 5 kV

1 Wasserkopf 2 Winde 3 Motor 4 Zusatzwinde 5 Anschlußkasten 6 Notfahreinrichtung 7 Energieverteilung

Kombination von Baueinheiten verschiedener Maschinentypen ist möglich z. B. EW 300 170 L oder EDW 200 230 LN

Eickhoff Shearer Loaders and ESA Mining Machines Principle of Unit Construction and Operating Range

Walzenlader mit Motoren an den Tragarmen

Shearer Loaders with Motors Mounted to the Ranging Arms

Baureihe 150/21 — 150/21 Series

Baureihe 230/21 — 230/21 Series

ESA-Maschinen

ESA Mining Machines

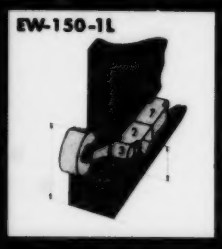
Baureihe 60 — 60 Series

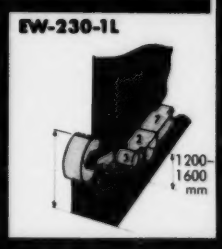
Baureihe 150 — 150 Series

Elektric haulage box

Einfach-Walzenlader

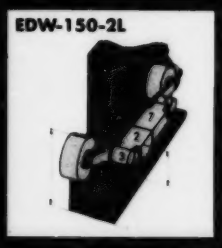
Single-ended ranging drum shearer





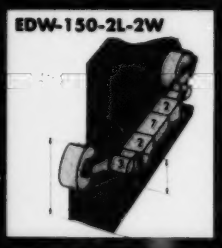
Doppel-Walzenlader Ein-Winden-Ausführung

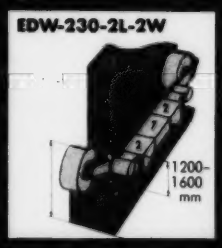
Double-ended ranging drum shearer Single-haulage version



Doppel-Walzenlader Zwei-Winden-Ausführung

Double-ended ranging drum shearer Double-haulage version





Doppel-Walzenlader Liegendmaschine

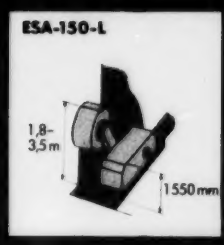
Double-ended ranging drum shearer Floor-based machine

165 kW 60 Hz — 250 kW 60 Hz

Hydraulische Winde/ Hydraulic haulage box

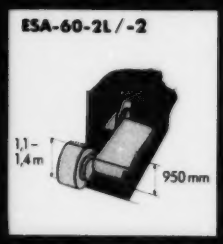
Grund-Ausführung

Standard Version



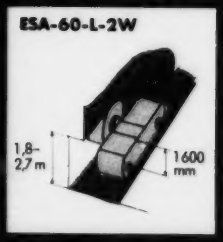
Doppel-Walze heb- senkbar oder starr

Double Drum Version with ranging drum or fixed drum



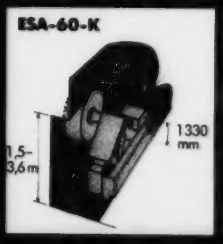
Zwei-Winden-Ausführung

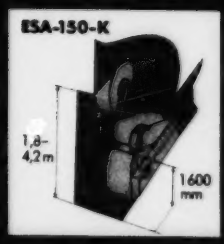
Version with 2 Haulage Units



Knick-Ausleger

Version with articulated arm





165 kW 60 Hz — 250 kW 60 Hz

1 gearhead 2 haulage unit 3 motor 4 booster haulage unit 5 connection box 6 emergency travelling control 7 power distribution. Units of different machine types can be combined e.g. EW-300/170-L or EDW-200/230-LN

Gebr. Eickhoff Maschinenfabrik und Eisengießerei mbH,
Postfach 10 06 29, Hunscheidtstr. 176, D-4630 Bochum 1,
Telefon (02 34) 77 71-1, Telex 17 234 318,
Telefax (02 34) 77 71-477

Doppelwalzenlader EDW-300-L

Gebr. Eickhoff
Maschinenfabrik u. Eisengießerei mbH
Postfach 10 06 29, Hunscheidtstraße 176
D-4630 Bochum 1
Telefon (02 34) 77 71-1
Teletex 234 318 eick
Telex 17 234 318 eick
Telefax (02 34) 77 71-477
Telegramme Eickhoffwerk

Double-Ended Ranging Drum Shearer EDW-300-L

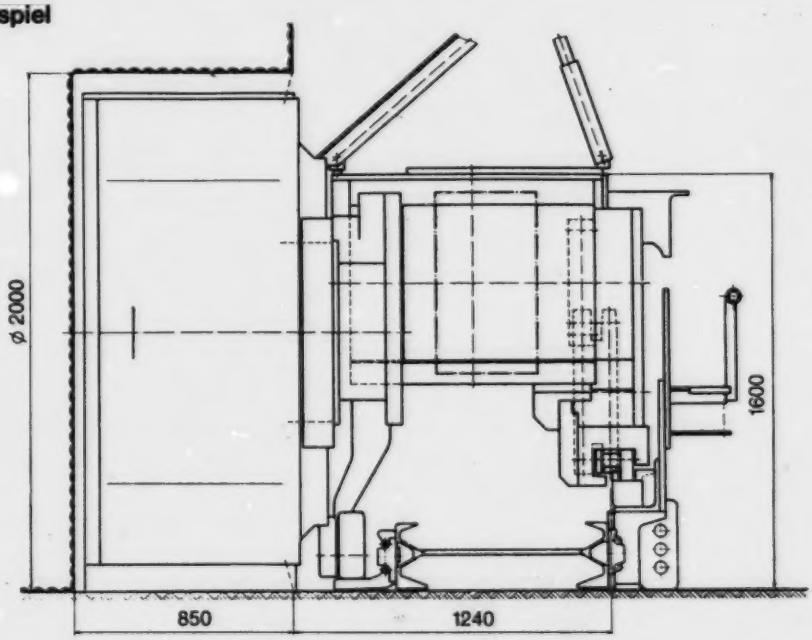
Doppelwalzenlader
EDW-300-L, EDW-600-L, EW-300-L

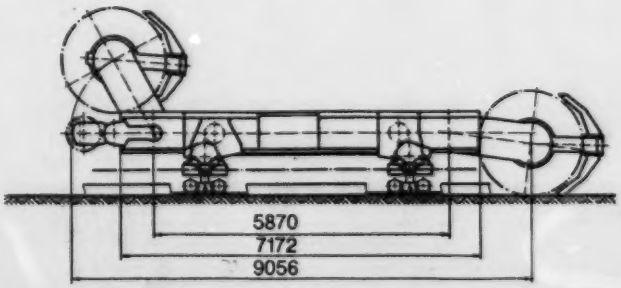
Der Eickhoff-Doppelwalzenlader ist zum Einsatz in mächtigen Flözen entwickelt worden, wo hohe Strebgewinnungsleistungen erzielt und die Strecken mitgeschnitten werden müssen. Er kann härteste Kohle und andere Mineralien schneiden. Die Maschine fährt auf am Förderer angeschraubten Fahrbahnen und ist mit vorhandenen Ausbau- und Fördereinrichtungen einsetzbar.

Double-Ended Ranging Drum Shearers
EDW-300-L, EDW-600-L, EW-300-L

The Eickhoff double-ended ranging drum shearer has been developed for use in thick seams where high outputs must be obtained and where it must cut out into the roadway. It is capable of cutting the hardest of coal and other minerals. Travelling on a track bolted to the face side of the conveyor, it can be used in conjunction with existing supports and conveyors.

Auslegungsbeispiel
Example





Technische Daten: **Technical Data:**		EDW-300-L	EDW-600-L	EW-300-L	Eicotrack® EW-300-L	Eicotrack® mit Zusatzwinde Eicotrack® with booster haulage
Installierte Leistung Motor power	kW	●		●	300 – 380	300 – 380
			●			600 – 760
Je Walze übertragbare Leistung Power transmitted per drum	kW	●	●	●	380	380
Betriebsspannung Operating voltage	V	●	●	●	1000	1000/3000/5000
Einsatzbereich, Mächtigkeit Seam thickness	m	●	●	●	1,8 – 3,8	1,8 – 3,8
Drehzahlen bei 50 Hz Drum speeds at 50 Hz	min^{-1} r.p.m.	●	●	●	23, 27, 32 37, 44, 50, 56	23, 27, 32 37, 44, 50, 56
Verwendbare Walzendurchmesser Drum diameters	mm	●	●	●	1400 – 2000	1400 – 2000
Schnittiefe Cutting depth	mm	●	●	●	650 – 1000	650 – 1000
Länge der Walzentragarme Length of ranging arms	mm	●	●	●	1255, 1593	1255, 1593
Hydr. Winde Hydraulic haulage box		●	●	●	EMM 30	EMM 30
Zugkraft Haulage pull	kN	●	●	●	115 – 257	230 – 514
Marschgeschwindigkeit Travelling speed	m/min	●	●	●	14,9 – 6,7	7,4 – 3,3
Maschinenlänge von Mitte Walze bis Mitte Walze bei EW bis Maschinenende Length between drum centres for EW up to machine end	mm	●				8380 – 9100
			●			9580 + 10300
				●	5740 + 6085	6540 + 6885
Maschinenbauhöhe Machine height	mm	●	●	●	1250 – 1700	1250 – 1700
Gesamtgewicht (ca.) Total weight (approx.)	t	●				38
			●			48
				●	25	30

GN/3000/DE/4/87

Doppelwalzenlader EDW-300-LH mit dem kettenlosen Vorschubsystem Eicotrack®

Double-Ended Ranging Drum Shearer EDW-300-LH with Eicotrack® Chainless Haulage System

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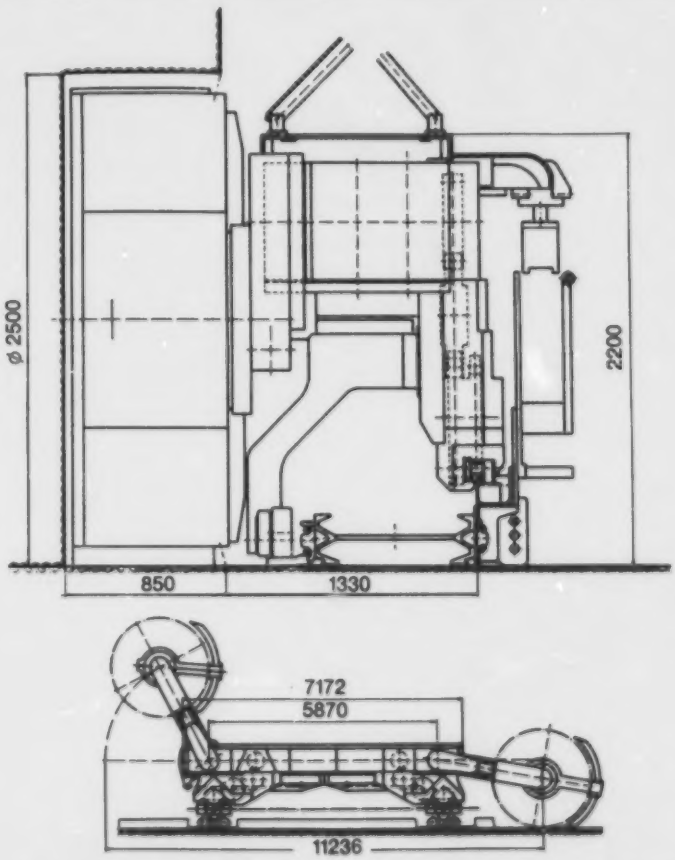
Einsatzmöglichkeiten in mächtigen Flözen, hohe Strebgewinnungsleistung und die Voraussetzung, Strecken mitzuschneiden, zeichnen den neuen Eickhoff-Doppelwalzenlader EDW-300-LH aus, der in härtester Kohle und anderen Mineralien untertage zum Einsatz kommt.
Natürlich ist auch dieser Walzenlader – wie alle anderen von Eickhoff – nach dem Baukastenprinzip konstruiert. Ausgerüstet mit einem 300-kW-Schrämmotor, fährt der EDW-300-LH auf am Förderer angeschraubten Fahrbahnen.
Durch das kettenlose Vorschubsystem Eicotrack® entfällt die Kettenabspannung, und der Walzenlader kann weit über die Antriebe hinausfahren (Verbesserung der Strebrandtechnik).
Trotz der installierten Antriebsleistung von 300 kW sind die Abmessungen und Gewichte so gering, daß Untertagetransport und Montage keine Schwierigkeiten bereiten. Darüber hinaus können vorhandene Ausbau- und Fördereinrichtungen weiter verwendet werden.

The new Eickhoff double-ended ranging drum shearer has been developed for use in thick seams where high outputs must be obtained and where it must cut out into the roadway. It is capable of cutting the hardest of coal and other minerals.
Same as all other Eickhoff shearers this shearer is also designed in line with the unit principle of construction. The EDW-300-LH is powered by a 300 kW motor and travels on a track bolted to the face side of the conveyor.

Due to the Eicotrack® chainless haulage system no chain tensioning devices are required at the face ends, so that the shearer can travel beyond the drive heads to cut out into the roadway and thus greatly improves face end work.

In spite of the high driving power of 300 kW the machine is of confined dimensions and weight, so that its transport and assembly underground are easy. Moreover, standard supports and conveyors can be used.

Auslegungsbeispiel
Example



Technische Daten: **Technical Data:**		EDW-300-LH	EDW-600-LH	EW-300-LH	Eicotrack®	Eicotrack® mit Zusatzwinde Eicotrack® with booster haulage
Installierte Leistung Motor power	kW	●				300 – 380
			●			600 – 760
				●	300 – 380	
Je Walze übertragbare Leistung Power transmitted per drum	kW	●	●	●	380	380
Betriebsspannung Operating voltage	V	●	●	●	1000/3300/5000	1000/3300/5000
Einsatzbereich, Mächtigkeit Seam thickness	m	●	●	●	2,2 – 5,5	2,2 – 5,5
Drehzahlen bei 50 Hz Drum speeds at 50 Hz	min^{-1} r.p.m.	●	●	●	23/27/32	23/27/32
Verwendbare Walzendurchmesser Drum diameters	mm	●	●	●	1800/2500	1800/2500
Schnittiefe Cutting depth	mm	●	●	●	650 – 1000	650 – 1000
Länge der Walzentragarme Length of ranging arms	mm	●	●	●	2228/2683	2228/2683
Elektrische Winde Eicotronik Electrical haulage box "Eicotronik"		●	●	●	EMM 30	EMM 30
Zugkraft Haulage pull	kN	●				230 – 520
			●			230 – 520
				●	120 – 260	
Marschgeschwindigkeit Travelling speed	m/min	●				7,5 – 3,3
			●			7,5 – 3,3
				●	15 – 4,3	
Maschinenlänge von Mitte Walze bis Mitte Walze bei EW bis Maschinenende Length between drum centres for EW up to machine end	mm	●				ca./approx. 10400
			●			ca./approx. 15000
				●	ca./approx. 6700	
Maschinenbauhöhe Machine height	mm	●	●	●	1650 – 2200	1650 – 2200
Gesamtgewicht (ca.) Total weight (approx.)	t	●				48
			●			54
				●	36	

GN/3000/DE/4/87

Doppelwalzenlader EDW-300-LN mit dem kettenlosen Vorschubsystem Eicotrack®

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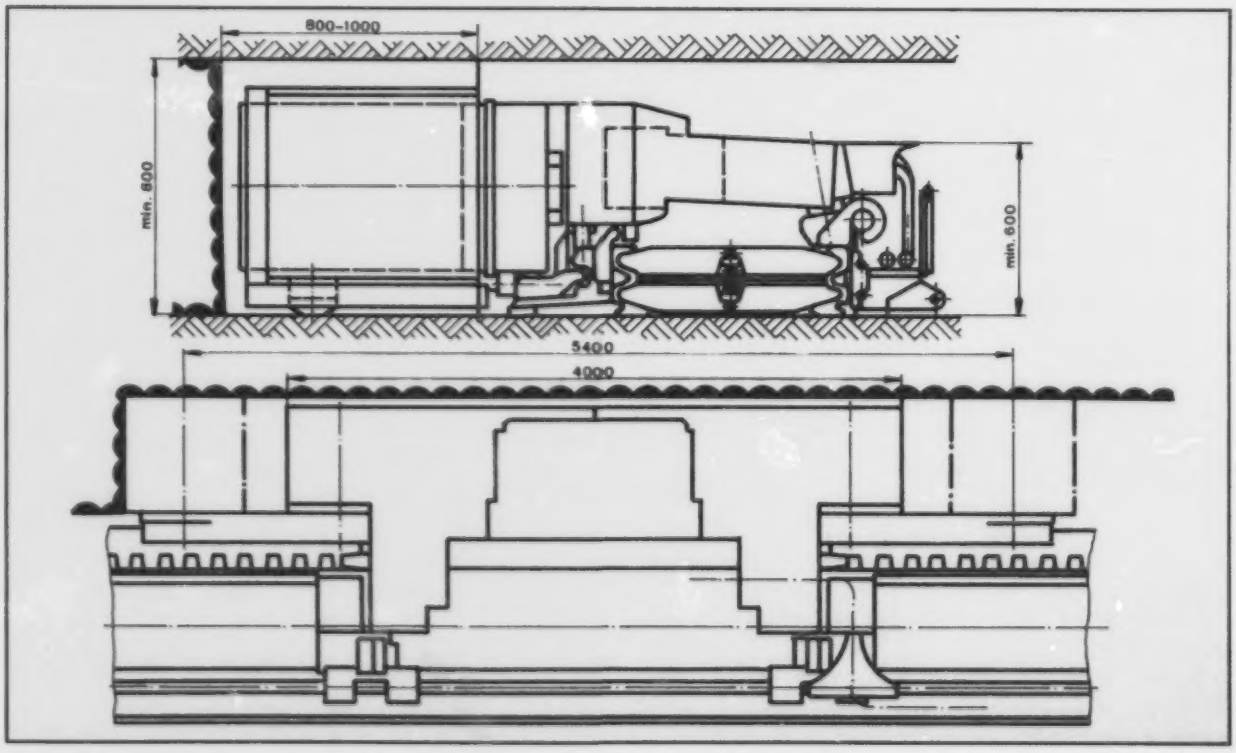
Double-Ended Ranging Drum Shearer EDW-300-LN with the chainless haulage system Eicotrack®

Der Walzenlader EDW-300-LN – eine Entwicklung für niedrige Flöze – ist extrem kurz und mit 335 kW besonders leistungsstark, wobei volle 300 kW in die voreilende Walze geleitet werden können.
Dieser neue Doppelwalzenlader ist mit elektrischen Winden ausgerüstet und fährt neben dem Förderer. Über dem Förderer befindet sich eine Brücke, an der der Maschinenkörper befestigt ist. Bei der Ausführung mit kohlenstoßseitigem Eicotrack® wird der Walzenlader an einem Rohr und beim versatzseitigen Eicotrack® am Triebstock geführt.
Auf der Stoßseite hat der EDW-300-LN zwei Kufen, die auf einer am Förderer angeschraubten Fahrbahn gleiten. Diese Fahrbahn ist so konstruiert, daß der Förderer leicht ins neue Feld gerückt werden kann. Das kohlenstoßseitige Eicotrack®-System ist eine Kombination von Nocken-Zahnstange und Fahrbahn. Unter dem Maschinenkörper befindet sich eine hydraulisch beaufschlagte Stützkufe, die den Walzenlader stabilisiert. Die voreilende Walze, deren Durchmesser der Flözmächtigkeit entspricht, schneidet den Maschinenkörper frei und die nacheilende Walze die Restkohle am Hangenden.

The shearer loader EDW-300-LN – a new development for thin seams – is extremely short and with its motor rating of 335 kW particularly powerful. The full power of 300 kW can be transmitted to the leading drum.
This new double-ended ranging drum shearer is equipped with electrical haulage units and travels alongside the conveyor. A bridge to which the machine body is mounted straddles the face conveyor. If the Eicotrack® system is positioned on the face side the shearer loader is guided by a tube, and if it is positioned on the goaf side the Eicotrack® rack bars serve as a guide.
On the face side the EDW-300-LN is equipped with two shoes which slide on the travelling tracks bolted to the conveyor. The design of these travelling tracks ensures that the conveyor can be easily shifted into the new web. The Eicotrack® system on the face side is a combination of a cam-type rack bar and a travelling track. A hydraulically operated stabilizer is provided underneath the machine body.
The leading drum, the diameter of which corresponds to the seam thickness, clears the way for the machine body and the trailing drum cuts the coal left at the roof.



Technische Daten: **Technical Data:**		Versatzs. Eicotrack® Eicotrack®System on the goaf side	Kohlenstoßs. Eicotrack® Eicotrack®System on the face side
Installierte Leistung Motor power	kW	335	335
Je Walze übertragbare Leistung Power transmitted per drum	kW	300	300
Betriebsspannung Operating voltage	V	1000	1000
Einsatzbereich, Mächtigkeit Seam thickness Mit Walzentragarm 1060 mm With ranging arm 1060 mm	m	1,0 – 1,3	0,8 – 1,3
Mit Walzentragarm 1300 mm With ranging arm 1300 mm	m	1,1 – 1,7	1,1 – 1,7
Walzendrehzahlen bei 50 Hz Drum speeds at 50 Hz bei 1060 mm Walzentragarm in 1060 mm ranging arm	min^{-1} r.p.m.	53/64	53/64
bei 1300 mm Walzentragarm in 1300 mm ranging arm	min^{-1} r.p.m.	39/50	39/50
Verwendbare Walzendurchmesser Drum diameters Bei Walzentragarm 1060 mm With ranging arm 1060 mm	mm	800 – 1200	800 – 1200
Bei Walzentragarm 1300 mm With ranging arm 1300 mm	mm	1100 – 1600	1100 – 1600
Schnittiefe Cutting depth	mm	800 – 1000	800 – 1000
Länge der Walzentragarme Length of ranging arms	mm	1060 + 1300	1060 + 1300
Eicotronik Winde Eicotronik haulage unit	kW	2 x 17,5	2 x 17,5
Zugkraft Haulage pull	kN	221 – 353	221 – 353
Marschgeschwindigkeit Travelling speed	m/min	5,4 – 8,6	5,4 – 8,6
Maschinenlänge von Mitte Walze bis Mitte Walze Length between drum centres Mit Walzentragarm 1060 mm With ranging arm 1060 mm	m	5,4	5,4
Mit Walzentragarm 1300 mm With ranging arm 1300 mm	m	5,9	5,9
Maschinenbauhöhe Machine height	mm	700 – 1100	600 – 1000
Mittleres Gewicht (ca.) Total weight (approx.)	t	24	23

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Doppelwalzenlader EDW-380-L mit dem kettenlosen Vorschubsystem Eicotrack®

Double-Ended Ranging Drum Shearer EDW-380-L with the chainless haulage system Eicotrack®

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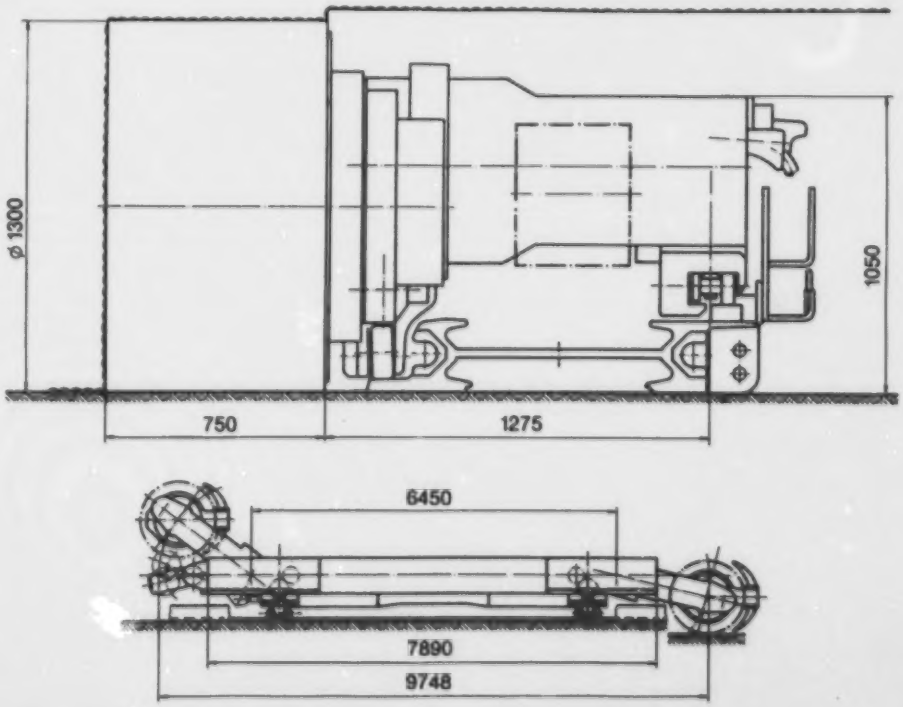
Der neue Walzenlader EDW-380-L wurde für einen Mächtigkeitsbereich von 1,35 – 3,6 Meter entwickelt. Mit seiner hohen, je Walze übertragbaren Leistung von 380 kW entspricht dieser EDW-380-L den Anforderungen des Bergbaus nach größeren Fördermengen auch aus Flözen geringerer Mächtigkeit.
Kennzeichnende Merkmale der neuen Gewinnungsmaschine sind die geringe Maschinenhöhe, der kompakte Maschinenkörper, an dessen Enden die Windenabtriebe angeordnet sind und die hohe installierte Leistung (435 oder 815 kW) bei Einspeisung mit Hochspannung von 3,3 kV.
Die Vorteile dieses Walzenladers basieren auf dem bewährten Prinzip der Verwendung von Walzenwindenköpfen, den integrierten elektrischen Winden und einem Energiegehäuse, in das wahlweise ein oder zwei 380-kW-Motoren installiert werden können. Der Einbau einer Zusatzwalze ist möglich. Alle Verbindungsleitungen sind innerhalb des Maschinenquerschnitts geschützt verlegt. Zusätzliche Abdeckungen sind nicht erforderlich.

The new Shearer Loader EDW-380-L is designed for a thickness range from 1.35 – 3.6 m.
With its high driving power of 380 kW which can be transmitted to each drum this EDW-380-L meets the requirements of the mining industry for higher outputs out of thinner seams.
Special features of the new power loader are the low machine height, the compact machine body fitted at either end with the haulage drives, and the high motor power installed (435 or 815 kW) for operation on a high voltage of 3,3 kV.
The advantages of this shearer loader are based on the proven principle involving the use of combined gearhead/haulage units, the integral electrical haulage units, and a power casing which houses optionally one or two 380 kW motors. A lump breaker can also be provided. All connection cables are protected within the machine contours. Additional covers are not required.

Auslegungsbeispiel
Example



Technische Daten: **Technical Data:**		EW-380-L	EDW-380-L	EDW-380/760-L
Installierte Leistung Motor power	kW	407,5 oder/or 435	435	815
Je Walze übertragbare Leistung Power transmitted per drum	kW	380	380	380
Betriebsspannung Operating voltage	V	3300	3300	3300
Einsatzbereich, Mächtigkeit Mit Tragarm 1649 mm With ranging arm 1986 mm Operating range, Seam thickness	m	1,35 – 3,6 1,35 – 4,0	1,35 – 3,6 1,35 – 4,0	1,35 – 3,6 1,35 – 4,0
Drehzahlen Mit Tragarm 1649 mm With ranging arm 1986 mm Drum speeds	min^{-1} r.p.m.	40 – 51 32 – 37 – 41	40 – 51 32 – 37 – 41	40 – 51 32 – 37 – 41
Verwendbare Walzendurchmesser Drum diameters	mm	1300 – 2000	1300 – 2000	1300 – 2000
Schnittiefe Cutting depth	mm	750 – 1000	750 – 1000	750 – 1000
Länge der Walzentragarme Length of ranging arms	mm	1649; 1986	1649; 1986	1649; 1986
2 elektr. Winden mit Gleichstrommotor 2 electrical haulage boxes with d.c. motor	kW	1 x 27,5 oder / or 2 x 27,5	2 x 27,5	2 x 27,5
Zugkraft Haulage pull	kN	153 – 251 oder / or 306 – 502	306 – 502	306 – 502
Marschgeschwindigkeit Travelling speed	m/min	5,8 – 9,6	5,8 – 9,6	5,8 – 9,6
Maschinenlänge von Mitte Walze bis Mitte Walze bei EW bis Maschinenende mit Walzentragarm 1649 mm Length between drum centres. for EW up to machine end with ranging arm 1649 mm	mm	8240	9748	9748
Maschinenbauhöhe Machine height	mm	1050 – 1400	1050 – 1400	1050 – 1400
Gesamtgewicht (ca.) Total weight (approx.)	t	31 – 35	38 – 43	41 – 46

DN/3000/DE/4/87

Eickhoff-Doppelwalzenlader Baureihe EDW-450 mit dem kettenlosen Vorschubsystem Eicotrack®

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Eickhoff Double-Ended Ranging Drum Shearer Loader EDW-450 series with the chainless haulage system Eicotrack®

Walzenlader dieser Baureihe gibt es in den Ausführungen mit einem 450-kW-Schneidmotor für Betriebsspannung bis 1000 V und mit zwei 500-kW-Schneidmotoren bei einer Betriebsspannung von 3,3 kV.

Während der EDW-450-L mit einem wassergekühlten 450-kW-Motor beide Walzen antreibt, stehen dem EDW-450/1000-L mit seinen beiden 500-kW-Motoren pro Walze 500 kW Schneidleistung zur Verfügung.

Die Doppelwalzenlader fahren natürlich kettenlos am Vorschubsystem Eicotrack® und erreichen mit ihren zwei elektrischen Winden Marschgeschwindigkeiten bis zu 726 m in der Stunde (EDW-450/1000-L).

Entwickelt wurden die Walzenlader der Baureihe EDW-450 für mächtige Flöze bis 5 Meter und zum Mitschneiden von Strecken. Sie werden im Schneidbetrieb über eigensichere Befehlsgeber – die sich an beiden Maschinenenden befinden – von Hand gesteuert.

Die Umrüstung auf Funk- oder Fernsteuerung ist jederzeit möglich.

Shearer loaders of this series exist with one 450 kW cutting motor for an operating voltage up to 1000 V and with two 500 kW cutting motors at an operating voltage of 3,3 kV.

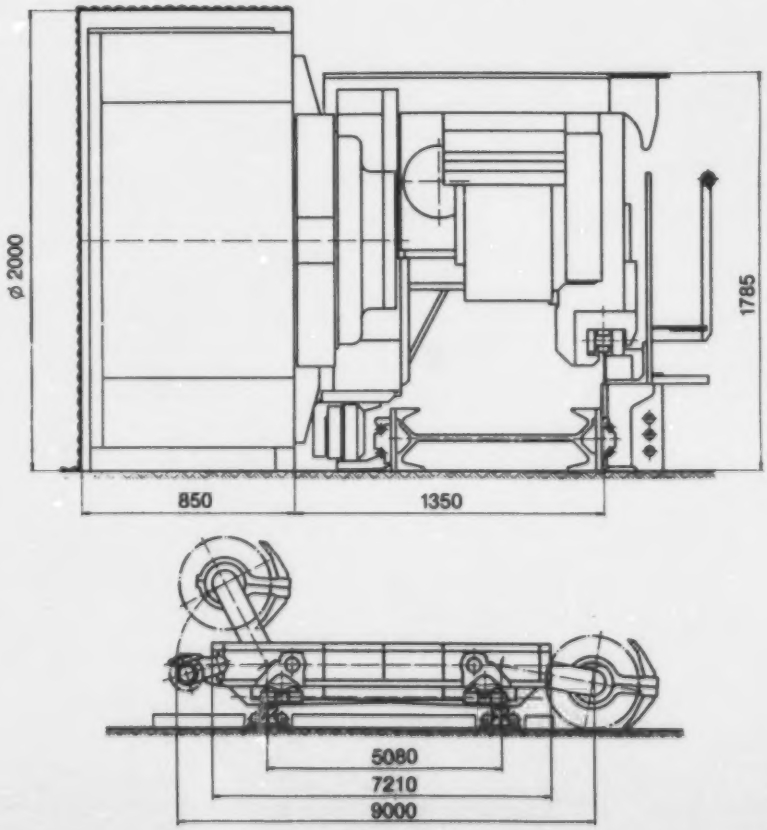
Whilst the EDW-450-L drives both drums with one water cooled 450 kW motor, the EDW-450/1000-L, with its two 500 kW motors, has 500 kW of cutting power available for each drum.

The double-ended ranging drum shearer loaders naturally drive on the chainless haulage system Eicotrack® and, with their two electric haulage units, reach travelling speeds of up to 726 m per hour (EDW-450/1000-L).

The shearer loaders of the EDW-450 series were developed for thick seams of up to 5 m and for cutting into the roadways. During the cutting operation they are manually controlled by intrinsically safe command transmitters which are situated at both ends of the machine.

Conversion to radio or remote control is possible at any time.

Auslegungsbeispiel
Example



Technische Daten: **Technical Data:**		**EDW-450-L**	**EDW-450/1000-L**
Installierte Leistung Motor power	kW	500	1080
Je Walze übertragbare Leistung Power transmitted per drum	kW	450	500
Betriebsspannung Operating voltage	V	1000	3300
Einsatzbereich Mächtigkeit Seam thickness	m	2,2 – 4,2	2,4 – 4,4
Drehzahlen Drum speeds	min^{-1} r.p.m.	23; 26; 30	23; 26; 30
Verwendbare Walzendurchmesser Drum diameters	mm	1800 – 2300	1800 – 2300
Schnittiefe Cutting depth	mm	850 – 1000	850 – 1000
Länge der Walzentragarme Length of ranging arms	mm	1960	1960
2 elektr. Winden mit Gleichstrommotor 2 electrical haulage boxes with d.c. motor	kW	je/each 25	je/each 40
Zugkraft Haulage pull	kN	353 – 650	356 – 633
Marschgeschwindigkeit Travelling speed	m/min	7,64 – 4,16	12,1 – 6,8
Maschinenlänge von Mitte Walze bis Mitte Walze Length between drum centres	mm	9000	10950
Maschinenbauhöhe Machine height	mm	1785	2000
Gesamtgewicht (ca.) Total weight (approx.)	t	54	72

GN/3000/DE/4/87

Doppelwalzenlader EDW-150-2L mit dem kettenlosen Vorschubsystem Eicotrack®

Double-Ended Ranging Drum Shearer EDW-150-2L with Eicotrack® Chainless Haulage System

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Der EDW-150-2L mit Eicotrack® dem kettenlosen Vorschubsystem von Eickhoff, ist mit zwei wassergekühlten 150-kW-Motoren ausgerüstet, die direkt an die schwenkbaren Walzentragarme angebaut sind. Dadurch ergibt sich eine kurze Maschinenbaulänge im Vergleich zu Maschinen gleicher Leistungsgröße.
Die üblichen Walzenkopfgetriebe entfallen, und die Motoren lassen sich einfacher auswechseln.
Der Walzenlader EDW-150-2L – kompakt und wartungsfreundlich – kann unabhängig von den Schrämmotoren verfahren werden. Und zwar über eine Winde, die durch einen separaten, regelbaren, wassergekühlten 23-kW-Elektro-Gleichstrommotor angetrieben wird.
Die Eicotronik-Winde EE 23 bildet mit dem benachbarten Gehäuse der Energieverteilung den eigentlichen Maschinenkörper.
Die Hydraulikzylinder zum Schwenken der Walzentragarme sind auf der Kohlenstoßseite angeordnet. Je nach Maschinenbauhöhe befinden sie sich geschützt im Maschinenkörper oder im Maschinenrahmen.

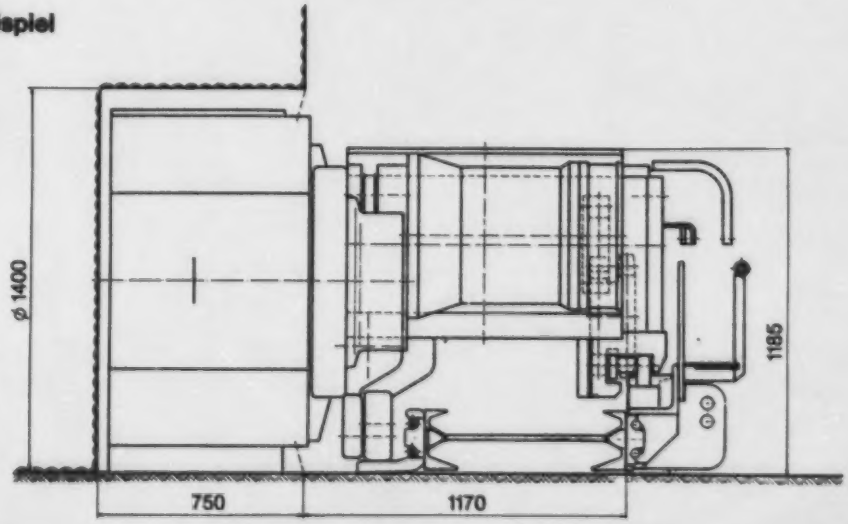
The EDW-150-2L with Eicotrack® Eickhoff's chainless haulage system, is powered by two water-cooled 150 kW motors which are directly mounted to the ranging arms. This results in a short machine length in comparison with conventional shearers of the same rating.

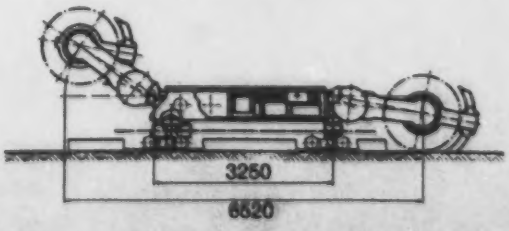
The conventional gearheads are omitted, and the motors are readily accessible for easy assembly.
The shearer loader EDW-150-2L – of compact design and easy maintenance – travels independently of the cutter motors, because the haulage is powered by its own variable speed, water-cooled 23 kW d. c. motor.

The Eicotronik haulage EE 23 and the adjacent connection box represent the actual machine body.

The hydraulic cylinders for raising and lowering the ranging arms are positioned on the face side. Depending on the machine height they are accommodated in the machine body or in the underframe.

Auslegungsbeispiel
Example





Technische Daten: **Technical Data:**		EDW-150-2L	EDW-150-2L-2W	Eicotrack®
Installierte Leistung Motor power	kW	●		328
			●	351
Je Walze übertragbare Leistung Power transmitted per drum	kW	●		150
			●	150
Betriebsspannung Operating voltage	V	●		1000
			●	1000
Einsatzbereich, Mächtigkeit Seam thickness	m	●		1,4 – 3,9
			●	1,5 – 4,1
Drehzahlen bei 50 Hz Drum speeds at 50 Hz	min^{-1} r.p.m.	●		23/30/37/48/55
			●	23/30/37/48/55
Verwendbare Walzendurchmesser Drum diameters	mm	●		1100/1800
			●	1100/1800
Schnittiefe Cutting depth	mm	●		650 – 840
			●	650 – 840
Länge der Walzentragarme Length of ranging arms	mm	●		1635/1714
			●	1635/1714
Elektrische Winde Eicotronik Electrical haulage box "Eicotronik"		●		EE – 23
			●	2 x EE – 23
Zugkraft Haulage pull	kN	●		112 – 210
			●	224 – 420
Marschgeschwindigkeit Travelling speed	m/min	●		10,5 – 5,6
			●	10,5 – 5,6
Maschinenlänge von Mitte Walze bis Mitte Walze Length between drum centres	mm	●		6520
			●	8710
Maschinenbauhöhe Machine height	mm	●		1100 – 1600
			●	1200 – 1600
Gesamtgewicht (ca.) Total weight (approx.)	t	●		21
			●	27,5

GN/3000/DE/4/87

Doppelwalzenlader EDW-230-2L-2W mit dem kettenlosen Vorschubsystem Eicotrack®

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Double-Ended Ranging Drum Shearer EDW-230-2L-2W with Eicotrack® Chainless Haulage System

Der EDW-230-2L-2W mit Eicotrack® dem kettenlosen Vorschubsystem von Eickhoff, ist mit zwei wassergekühlten 230-kW-Motoren ausgerüstet, die direkt an die schwenkbaren Walzentragarme angebaut sind. Dadurch ergibt sich eine kurze Maschinenbaulänge im Vergleich zu Maschinen gleicher Leistungsgröße.

Die üblichen Walzenkopfgetriebe entfallen, und die Motoren lassen sich einfacher auswechseln.

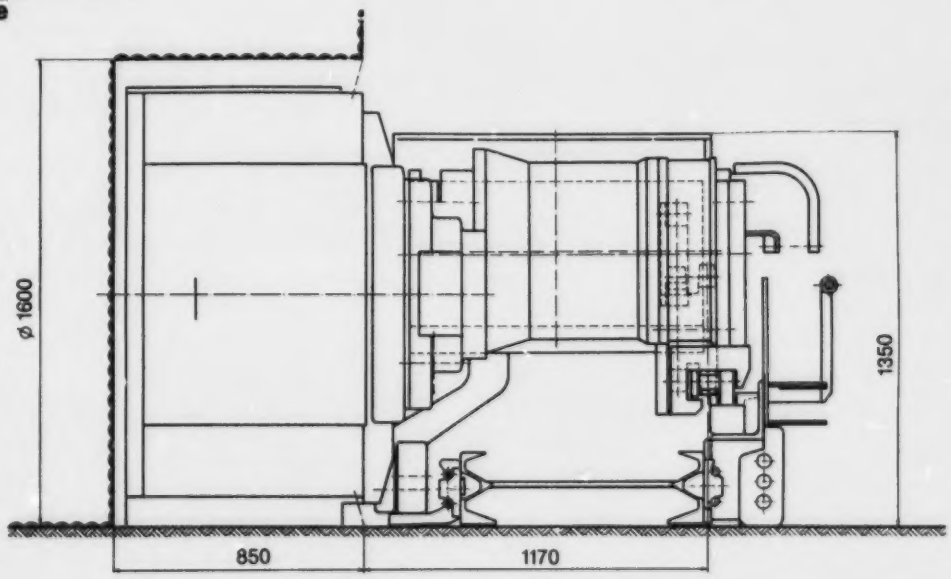
Der Walzenlader EDW-230-2L-2W – kompakt und wartungsfreundlich – kann unabhängig von den Schrämmotoren verfahren werden. Und zwar über zwei Winden, die durch zwei separate, regelbare, wassergekühlte 23-kW-Elektro-Gleichstrommotoren angetrieben werden.

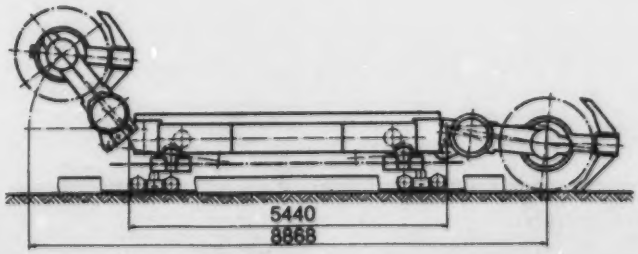
The EDW-230-2L-2W with Eicotrack® Eickhoff's chainless haulage system, is powered by two water-cooled 230 kW motors which are directly mounted to the ranging arms. This results in a short machine length in comparison with conventional shearers of the same rating.

The conventional gearheads are omitted, and the motors are readily accessible for easy assembly.

The shearer loader EDW-230-2L-2W – of compact design and easy maintenance – travels independently of the cutter motors, because the two haulage units are powered by two separate, variable speed, water-cooled 23 kW d.c. motors.

Auslegungsbeispiel
Example





Technische Daten: **Technical Data:**		EDW-230-2L-2W
Installierte Leistung Motor rating	kW	511
Je Walze übertragbare Leistung Power transmissible to each drum	kW	230
Betriebsspannung Operating voltage	V	1000
Einsatzbereich Operating range	m	1,6 – 3,8
Verwendbare Walzendurchmesser Drum diameters	mm	1500 – 2000
Schnittiefe Cutting depth	mm	850 – 1000
Drehzahlen (bei 50 Hz) Drum speed (at 50 Hz)	min^{-1} r.p.m.	23, 30, 32,5
Länge der Walzentragarme Length of ranging arms	mm	1714
Maschinenbauhöhe Machine height	mm	1200 – 1600
Eicotronik-Winden, Gesamt-Zugkraft Eicotronik haulage unit, haulage pull	kN	300 – 400
Marschgeschwindigkeit Travelling speed	m/min	8,3 – 6,3
Länge der Maschine von Mitte Walze bis Mitte Walze Length of machine between drum centres	m	8,9
Gesamtgewicht Das Gewicht variiert mit der Maschinenbauhöhe, dem Walzendurchmesser etc. Total weight The weight varies with the machine height, the drum diameter etc.	ca. t	35

GN/3000/DE/4/87

Eickhoff-
Stall- und Aufhauen-
maschine ESA-60-L

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Eickhoff
Stablehole and Face
Opening Machine ESA-60-L

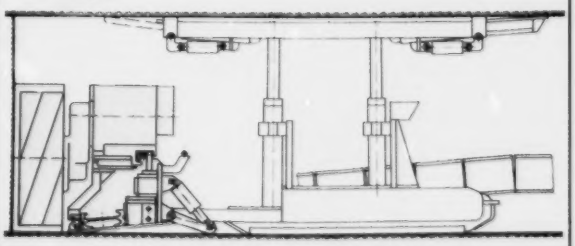
Ein ungewöhnlicher Name für eine ungewöhnliche Gewinnungsmaschine.
Konstruktiv so vielseitig ausgelegt, daß sie für die unterschiedlichsten Einsatzfälle geeignet ist.
Und zwar
- in Aufhauen genauso wie für das Auffahren vorgesetzter Strecken,
- zum Auskohlen von Maschinenställen, oder
- als kleine Gewinnungsmaschine in Kurzstreben.

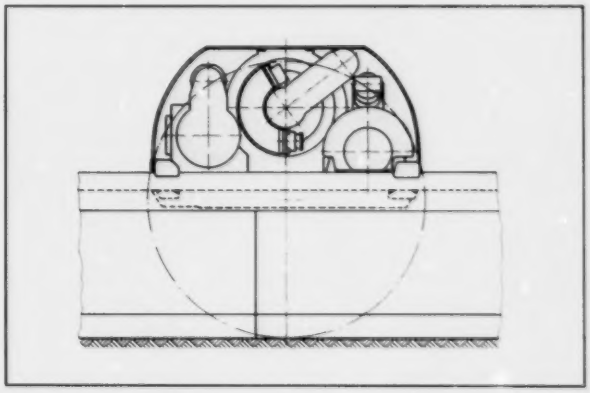
Die ESA-60-L – so die Kurzbezeichnung – ist ausgerüstet mit einer um 360° schwenkbaren Walze. Verlagert an einem kurzen Tragarm, können alle feststehenden Bauteile, wie Maschinenrahmen, Motorgehäuse etc. an beiden Maschinenenden freigeschnitten werden.
Der Elektromotor liegt im Zentrum der Maschine. Tragarm und Walze lassen sich am Hangenden und am Liegenden durchschwenken. Die jeweilige max. Abbauhöhe entspricht dem Walzendurchmesser plus 2mal Tragarmlänge. Der Maschinenvorschub erfolgt über einen hydraulisch-mechanischen Antrieb am Triebstock. Das Schwenken des Tragarmes übernimmt ein gleichartiger Antrieb im Verlagerungsgehäuse.
Beim Aufhauen, Auffahren und Auskohlen wird die Maschine keilförmig in den Stoß gefahren.

An unusual name for an unusual coal getter.
Of versatile design, it is suitable for a multitude of applications. It can be used:
- for face opening and equally well for driving advanced headings;
- for cutting stableholes;
- as a small coal getter on short faces.

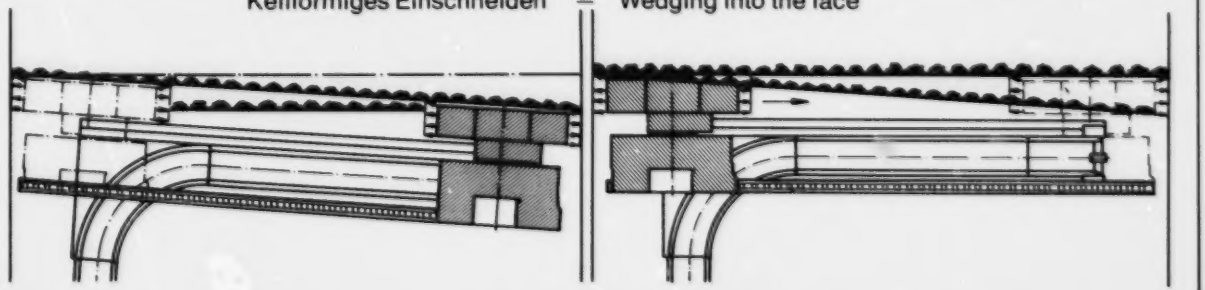
The ESA-60-L is equipped with a drum mounted on a short ranging arm which can be pivoted endlessly clockwise and anti-clockwise through the full circle of 360° thus clearing the way on either side for all fixed machine components such as the underframe, the motor casing etc.
The electric motor is positioned in the centre of the machine. The ranging arm with the drum can be slewed to the opposite side by swinging either across the roof or the floor. The maximum cutting height corresponds to the drum diameter plus twice the length of the ranging arm. A hydraulically powered, mechanical drive hauls the machine on the rack. The ranging arm is pivoted by a similar drive accommodated in the main machine casing.
For face opening, advanced headings and stablehole operations the machine wedges itself into the face.

Auslegungsbeispiel
Example





Keilförmiges Einschneiden – Wedging into the face



Technische Daten Technical Data:		Tragarmlänge Length of Ranging Arm		
		250	500	750
Installierte Leistung Motor power	60 kW	●	●	●
Übertragbare Leistung an der Walze Power transmitted to the drum	60 kW	●	●	●
Betriebsspannung Operating voltage	500 V 1000 V	● ●	● ●	● ●
Einsatzbereich Seam thickness	1,4 – 2,2 m 1,65 – 2,7 m 1,9 – 3,2 m	●	●	●
Verwendbarer Walzendurchmesser Drum diameters	1400 – 1700 mm	●	●	●
Maschinenbauhöhe Machine height	1285 – 1435 mm 1535 – 1685 mm 1785 – 1935 mm	●	●	●
Walzendrehzahl (bei 50 Hz) Drum speed (at 50 Hz)	32 min^{-1} 32 r.p.m.	●	●	●
Schnittiefe Cutting depth	420 – 625 mm	●	●	●
Winde hydr. (1 oder 2) Haulage unit (1 or 2)	Antrieb von 60-kW-E-Motor drive of 60 kW electric motor	●	●	●
Zugkraft Haulage pull	110 kN	●	●	●
Marschgeschwindigkeit Travelling speed	1 – 3 m/min 1 – 6 m/min	●	●	●
Maschinenlänge Machine length	m	1,5	1,5	2,1
Gesamtgewicht (ca.) Total weight (approx.)	t	5,5	6	9

GN/3000/DE/4/87

Eickhoff Strebrand- und Vortriebsmaschine ESA-60-K

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Eickhoff Face End and Heading Machine ESA-60-K

Das macht diese neuentwickelte Einwalzenmaschine von Eickhoff so vielseitig: Ihr Tragarm ist im Zentrum der Maschine gelagert, was ihr die Möglichkeit gibt, sich nach der einen und der anderen Maschinenseite selbst freizuschneiden.

Deshalb läßt sich die ESA-60-K wahlweise als Strebrandmaschine, als Vortriebsmaschine oder als Kombination von beiden einsetzen. Und zwar in Mächtigkeiten von 1,6 bis 3,6 Metern.

Die 12 Tonnen schwere und 2,6 Meter lange Maschine erreicht eine maximale Marschgeschwindigkeit von 4,8 Meter in der Minute bei einer Windenzugkraft von 150 kN.

Für den Maschinenvorschub sorgt der hydraulisch-mechanische Antrieb am Triebstock.

Das Antriebsrad der ESA-60-K liegt auf der Versatzseite. Über den 60-kW-Motor wird die Walze angetrieben, der Tragarm geschwenkt und die Maschine verfahren.

Die Besonderheiten der ESA-60-K: Der gesamte Maschinenkörper läßt sich hydraulisch anheben. Und auf Wunsch kann diese neue Maschine auch mit einer Profil- und Richtungssteuerung ausgerüstet werden.

This renders the new single-ended ranging drum shearer of Eickhoff so versatile: Its ranging arm is supported in the centre of the machine which enables it to cut its own way on either side.

The ESA-60-K can therefore be installed as a face end machine, as a roadheader, or as a combination of both in seams ranging from 1,6 to 3,6 m in thickness.

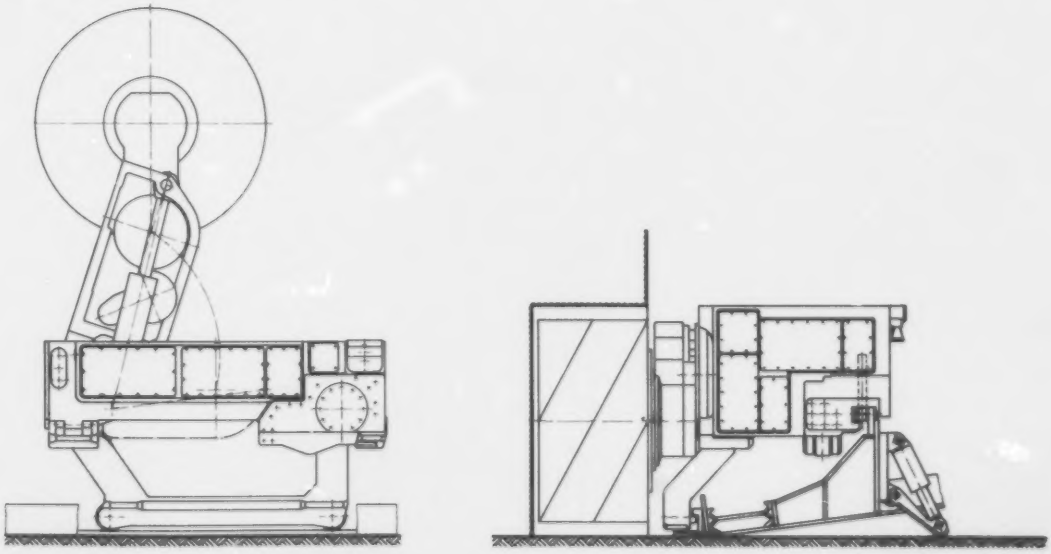
The machine having a weight of 12 t and a length of 2,6 m reaches a travelling speed of max. 4,8 m/min. at a haulage pull of 150 kN.

The machine travels on rack bars by means of its hydromechanical drive.

The drive wheel of the ESA-60-K is positioned on the goaf side. The 60 kW motor drives the drum and it serves for slewing the ranging arm and for traversing the machine.

A special feature of the ESA-60-K is that the whole machine body can be lifted hydraulically. If required, the new machine can be equipped with a profile and alignment control system.

Auslegungsbeispiel
Example



Technische Daten: Technical Data:	ESA-60-K
Installierte Leistung Motor power	60 kW
Übertragbare Leistung an der Walze Power transmitted to the drum	60 kW
Betriebsspannung Operating voltage	500 V/1000 V
Einsatzbereich (Mächtigkeit) bei Walzendurchmesser 1600 mm Operating range (seam thickness) with a 1600 mm dia. drum	1600 – 2545 mm (aus dem Stand) 3635 mm (angehoben) 1600 – 2545 mm (from basic position) 3635 mm (lifted)
Verwendbarer Walzendurchmesser Drum diameter	1600 mm (1800 mm)
Walzentragarmlänge Length of ranging arm	750 mm
Maschinenbauhöhe Machine height	1330 mm bei 700 mm Triebstockhöhe 1330 mm with 700 mm rack bar height
Walzendrehzahl (bei 50 Hz) Drum speed (at 50 Hz)	32 min^{-1} 32 r.p.m.
Schwenkantrieb Swivel drive	Antrieb vom 60 kW-E-Motor Drive from the 60 kW electric motor
Schwenkmoment Swivel torque	31 kNm
Schnittiefe Cutting depth	625 mm
Winde (hydr.) Haulage	Antrieb vom 60 kW-E-Motor Drive from the 60 kW electric motor
Zugkraft Haulage pull	110 kN
Marschgeschwindigkeit Travelling speed	4,8 m/min
Maschinenlänge Machine length	2375 mm
Gesamtgewicht Total weight	ca. 12 t approx. 12 t

GN/3000/DE/4/87

Eickhoff-Kurzfrontgewinnungsmaschine ESA-150-L mit dem kettenlosen Vorschubsystem Eicotrack®

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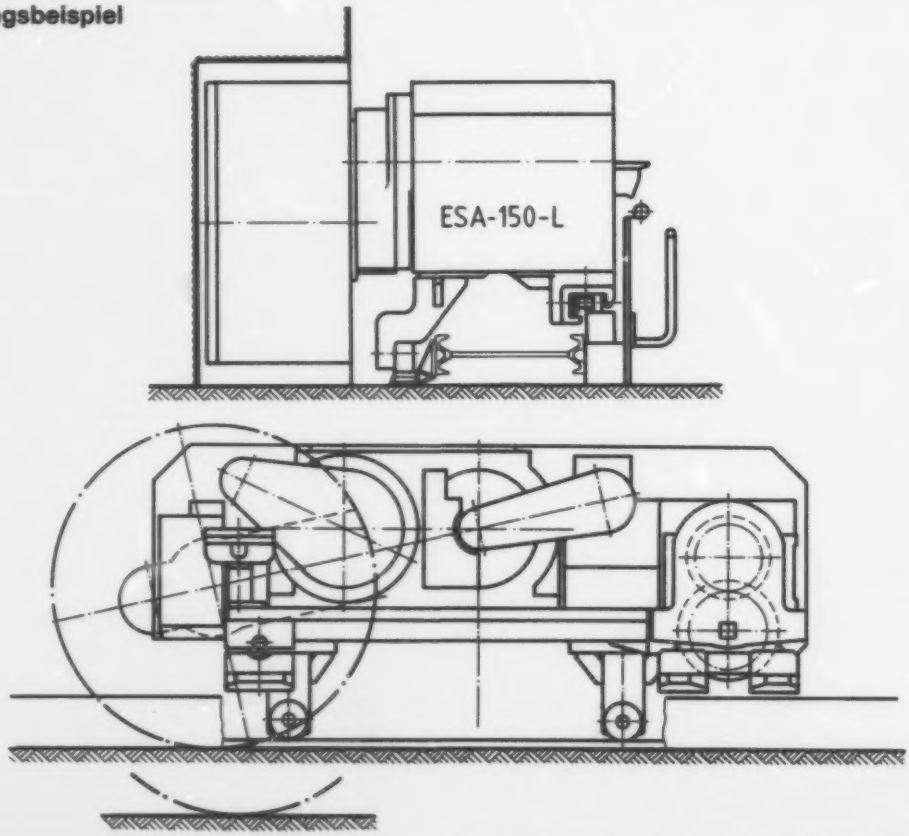
Eickhoff Shortwall Shearer Loader ESA-150-L with the Chainless Haulage System Eicotrack®

Die Kurzfrontgewinnungsmaschine ESA-150-L ist eine leistungsstarke Ein-Walzen-Maschine, die sich nach allen Seiten hin selbst freischneiden kann.
Mit der ESA-150-L wird Kohle, Kali und Erz im Strebbau unter Tage vollmechanisch bis 3,8 m Abbauhöhe (Flözmächtigkeit) bei entsprechendem Walzendurchmesser gewonnen.
Ausgerüstet ist die ESA-150-L mit einer um 360° schwenkbaren Walze, die an einem Tragarm verlagert ist. So können alle feststehenden Bauteile, wie Maschinenrahmen, Motorgehäuse etc. an beiden Maschinenenden freigeschnitten werden.
Der Elektromotor liegt im Zentrum der Maschine.
Der Maschinenvorschub erfolgt über einen hydraulisch-mechanischen Antrieb am Triebstock. Der Triebstock bildet zusammen mit der Winde das Fortbewegungselement. Das Antriebsrad der Maschine liegt versatzseitig und ist Bestandteil des Eicotrack®-Systems, mit dem sich die ESA-150-L gleitend am Stoß entlang zieht.

The shortwall shearer loader ESA-150-L is a powerful single-ended ranging drum shearer which clears its way to all sides. In addition to mining coal, the ESA-150-L can also be used for the fully mechanized extraction of potash and ore in underground mines up to a cutting height of 3,8 m (seam thickness), the latter depending on the drum diameter installed.
The ESA-150-L is equipped with a drum mounted on a ranging arm which can be pivoted through 360° thus clearing its way on either side for all fixed machine components such as the underframe, the motor casing etc. The electric motor is positioned in the centre of the machine. A hydraulically powered, mechanical drive hauls the machine on the rack. Together with the haulage unit the rack is part of the haulage assembly. The drive wheel of the shearer is positioned on the goaf side and is a component of the Eicotrack® system by means of which the ESA-150-L traverses the face.

Auslegungsbeispiel
Example



Technische Daten: **Technical Data:**	ESA-150-L
Installierte Leistung Motor power	150 kW
Übertragbare Leistung an der Walze Power transmitted to the drum	150 kW
Betriebsspannung Operating voltage	1000 V
Einsatzbereich Mächtigkeit Seam thickness	1800-3800 mm
Verwendbarer Walzendurchmesser Drum diameter	1400-1800 mm
Walzentragarmlänge Length of ranging arm	1050 mm 1335 mm 1600 mm
Maschinenbauhöhe Machine height	1500 mm bei Triebstockhöhe 400 mm 1500 mm with 400 mm rack height
Walzendrehzahl (bei 50 Hz) Drum speed (at 50 Hz)	32 min^{-1} bei Planetengetriebe ø 690 39 min^{-1} bei Planetengetriebe ø 585 32 r.p.m. with planetary gearing ø 690 39 r.p.m. with planetary gearing ø 585
Schwenkantrieb Swivel drive	Antrieb von 150-kW-E-Motor drive from 150 kW motor
Schwenkmoment Swivel torque	150 kNm
Schnittiefe Cutting depth	625 mm bei Planetengetriebe ø 585 750 mm – 800 mm bei Planetengetriebe ø 690 625 mm with planetary gearing ø 585 750 – 800 mm with planetary gearing ø 690
Winde (hydr.) Zugkraft Haulage pull	300-kN-Antrieb von 150-kW-E-Motor 300-kN-drive from 150 kW motor
Marschgeschwindigkeit Travelling speed	6,0 m/min
Maschinenlänge Machine length	3200 mm
Gesamtgewicht Total weight	ca. 16 t approx. 16 t

GN/3000/DE/4/87

Eickhoff Strebrand- und Vortriebsmaschine ESA-150-K

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Eickhoff Face End and Heading Machine ESA-150-K

Das macht diese neuentwickelte Einwalzenmaschine von Eickhoff so vielseitig: Ihr Tragarm ist im Zentrum der Maschine gelagert, was ihr die Möglichkeit gibt, sich nach der einen und der anderen Maschinenseite selbst freizuschneiden.

Deshalb läßt sich die ESA-150-K wahlweise als Strebrandmaschine, als Vortriebsmaschine oder als Kombination von beiden einsetzen. Und zwar in Mächtigkeiten von 1,8 bis 4,2 Metern.

Die 23 Tonnen schwere und 3,3 Meter lange Maschine erreicht eine maximale Marschgeschwindigkeit von 4,50 Meter in der Minute bei einer Windenzugkraft von 250 kN.

Für den Maschinenvorschub sorgt der hydraulisch-mechanische Antrieb am Triebstock.

Das Antriebsrad der ESA-150-K liegt auf der Versatzseite. Über den 150-kW-Motor wird die Walze angetrieben, der Tragarm geschwenkt und die Maschine verfahren.

Die Besonderheit der ESA-150-K: Der gesamte Maschinenkörper läßt sich hydraulisch anheben. Und auf Wunsch kann diese neue Maschine auch mit einer Profil- und Richtungssteuerung ausgerüstet werden.

This renders the new single-ended ranging drum shearer of Eickhoff so versatile: Its ranging arm is supported in the centre of the machine which enables it to cut its own way on either side.

The ESA-150-K can therefore be installed as a face end machine, as a roadheader, or as a combination of both in seams ranging from 1,8 to 4,2 m in thickness.

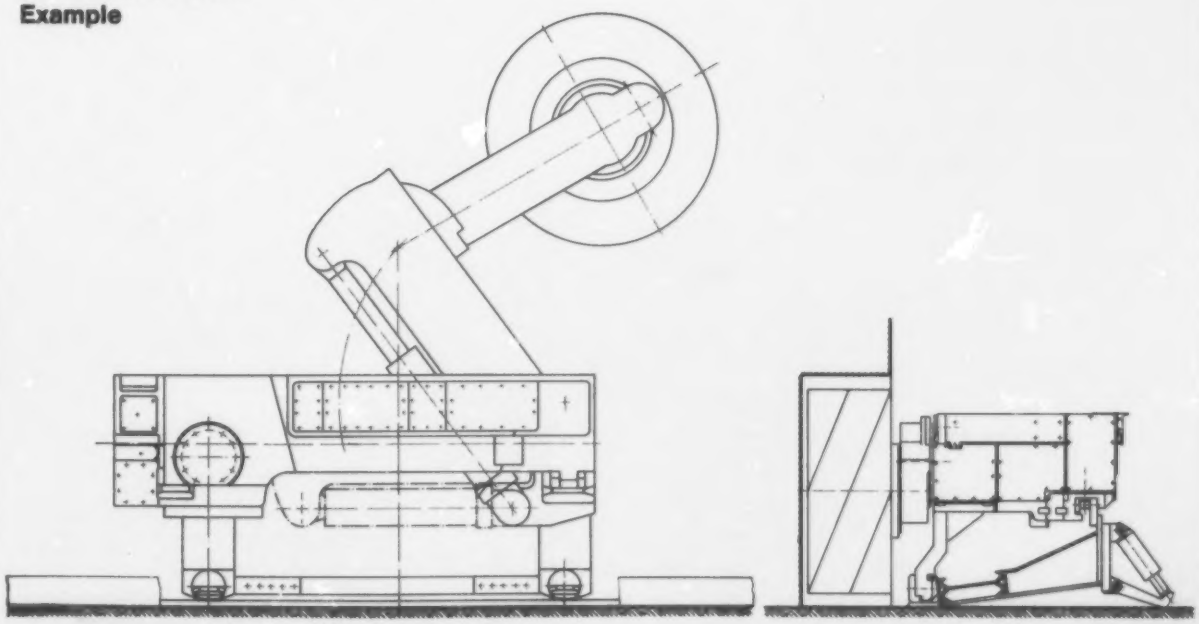
The machine having a weight of 23 t and a length of 3,3 m reaches a travelling speed of max. 4,50 m/min. at a haulage pull of 250 kN.

The machine travels on rack bars by means of its hydromechanical drive.

The drive wheel of the ESA-150-K is positioned on the goaf side. The 150 kW motor drives the drum and it serves for slewing the ranging arm and for traversing the machine.

A special feature of the ESA-150-K is that the whole machine body can be lifted hydraulically. If required, the new machine can be equipped with a profile and alignment control system.

Auslegungsbeispiel
Example



Technische Daten: **Technical Data:**	ESA-150-K
Installierte Leistung Motor power	150 kW
Übertragbare Leistung an der Walze Power transmitted to the drum	150 kW
Betriebsspannung Operating voltage	500 V / 1000 V
Einsatzbereich Mächtigkeit Seam thickness	1800 – 3550 mm (aus dem Stand) 4200 – 4900 mm (angehoben) 1800 – 3550 mm (from basic position) 4200 – 4900 mm (lifted)
Verwendbarer Walzendurchmesser Drum diameter	1600 mm
Walzentragarmlänge Length of ranging arm	1600 mm
Maschinenbauhöhe Machine height	1600 mm bei Triebstockhöhe 850 mm 1600 mm with 850 mm rack height
Walzendrehzahl (bei 50 Hz) Drum speed	34 min^{-1} 34 r.p.m.
Schwenkantrieb (hydr.) Swivel drive	Antrieb von 150-kW-E-Motor drive of 150 kW motor
Schwenkmoment Swivel torque	240 kNm
Schnittiefe Cutting depth (web)	780 mm
Winde (hydr.) Zugkraft Haulage pull	230 kN – Antrieb von 150-kW-E-Motor 230 kN – drive of 150 kW motor
Marschgeschwindigkeit Travelling speed	2,4 m/min (4,2 m/min)
Maschinenlänge Machine length	3310 mm
Gesamtgewicht Total weight	ca. 23 t approx. 23 t

GN/3000/DE/4/87

Die Eickhoff-Zusatzwalze für die Walzenlader-Baureihen EDW-200-L, EDW-300-L, EDW-380-L und EDW-450-L

The Eickhoff Lump Breaker for the Shearer Loader Series EDW-200-L, EDW-300-L, EDW-380-L and EDW-450-L

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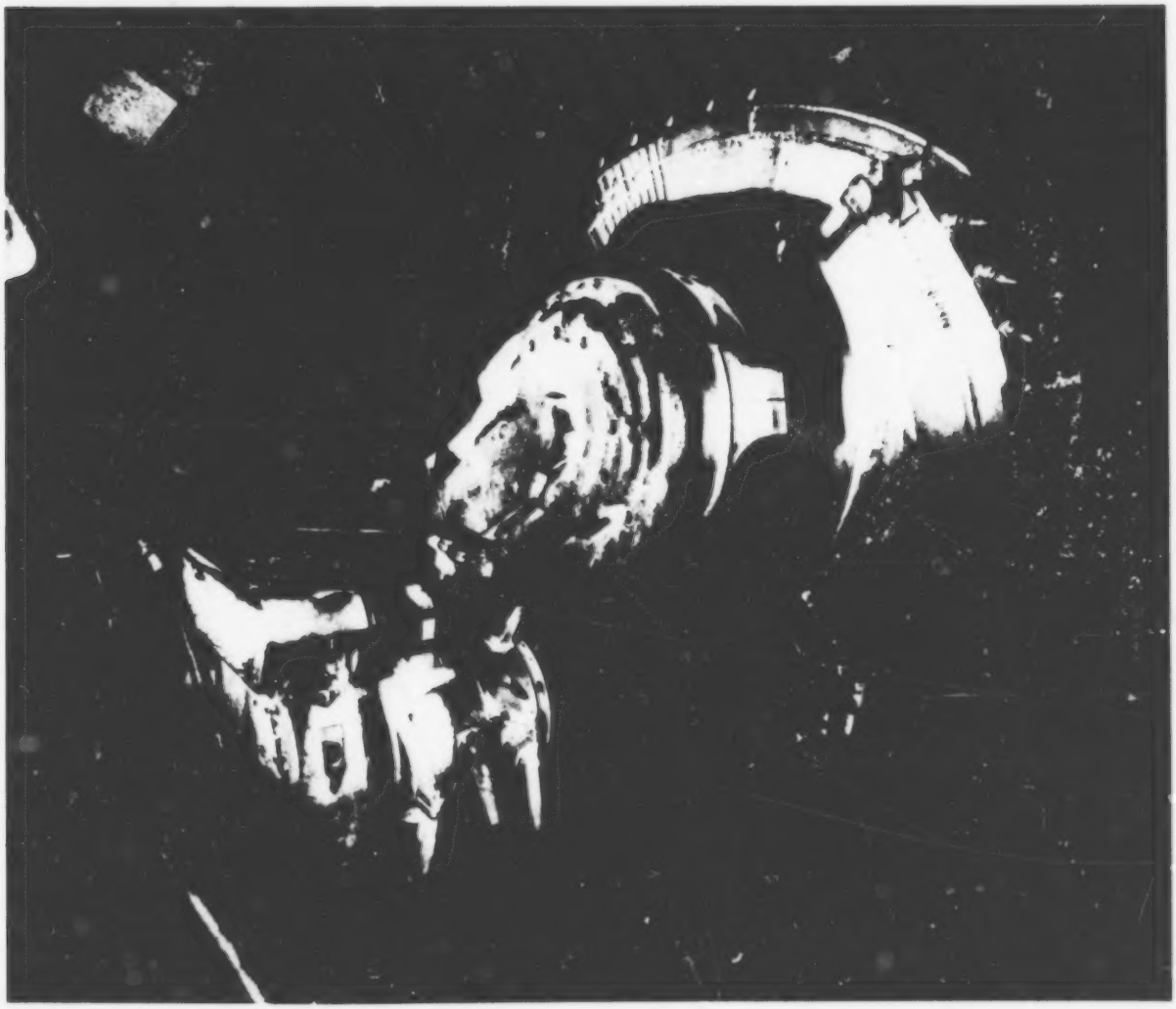
Die Zusatzwalze ist stirnseitig an der Fördereinlaufseite des Doppelwalzenladers angeordnet. Sie zerkleinert das Fördergut vor dem Maschinenportal und verhindert so Maschinenstillstände, die durch Förderstau hervorgerufen werden können. Die Zusatzwalze wird vom Schrämmotor des Walzenladers angetrieben. Ein an der Maschine verschraubtes Getriebe trägt das Schwenkgetriebe mit der eigentlichen Zusatzwalze.

The lump breaker is mounted to the front side of the shearer loader where the conveying material enters the clearance underneath the machine. It crushes the conveying material and therefore prevents machine stoppages due to large lumps and slabs. The lump breaker is driven by the shearer motor. A gearbox bolted to the machine supports the ranging gearing allowing for height adjustment as well as the actual lump breaker.

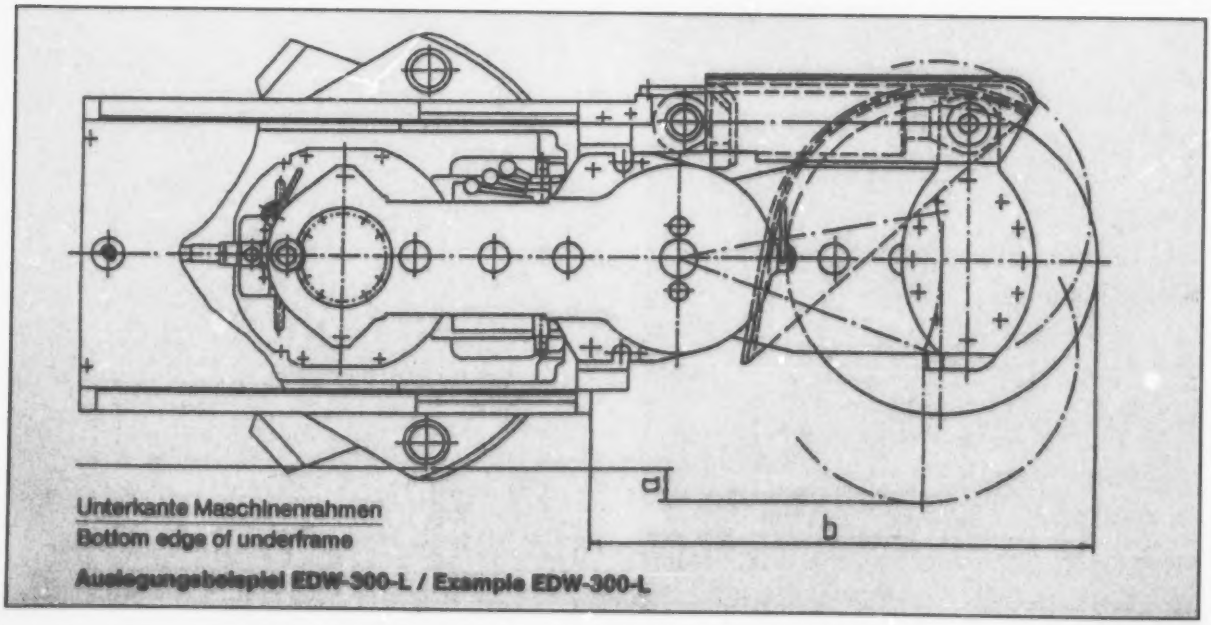


Während die Zusatzwalzen der Baureihen EDW-200-L, 300-L und EDW-380/760-L über ein versatzseitig angeordnetes Getriebe vom Walzenkopf aus angetrieben werden, erfolgt der Antrieb der Zusatzwalze bei der Baureihe EDW-450-L über eine Schaftwelle – sie befindet sich auf dem Walzenwindenkopf – und über ein stirnseitig angeordnetes Kegelstirnradgetriebe. Die Baureihe EDW-300-LH dagegen läßt sich überhaupt nicht mit Zusatzwalze ausrüsten.
Die Zusatzwalzen sind über Hydraulikzylinder in der Höhe verstellbar.
Oberhalb der Zusatzwalze, und zwar in der Abdeckung, befinden sich Wasser-Sprühdüsen zur Staubbekämpfung.
Ausgekuppelt werden die Zusatzwalzen-Getriebe von Hand durch Zahnkupplungen. Eine zusätzlich eingebaute Freischaltkupplung begrenzt die angegebenen Leistungen.

The lump breakers of the series EDW-200-L, 300-L and EDW-380/760-L are driven from the goaf side of the gearhead whereas the lump breaker of the EDW-450-L series is driven by an extension shaft – which is also provided on the gearhead/haulage unit – and by a spur bevel wheel gearbox positioned on the front side. The EDW-300-LH series, however, cannot be equipped with a lump breaker at all.
The height of the lump breakers is adjustable by hydraulic cylinders.
Water sprays in the cover of the lump breaker serve for dust suppression.
The lump breakers are disengaged by manually operated gear clutches.
An additionally installed overload shifting clutch limits the powers specified.

Technische Daten		EDW-200-L und/and EDW-200/230-L	EDW-300-L und/and EDW-300/380-L	EDW-380-L und/and EDW-380/760-L	EDW-450-L und/and EDW-450/1000-L	Technical Data
Leistung	kW	325*	270	265	350	power
Drehzahl (50 Hz)	min^{-1}	192	158	206	171	drum speed r.p.m.
Schnittgeschwindigkeit	m/s	7	5,8	5,4	6,3	cutting speed
Walzendurchmesser	mm	700	700	500	700	drum diameter
Walzenbreite	mm	400				drum width
Unterschnitt a	mm	135 bis/to 217	165 bis/to 260	86	80 bis/to 248	undercut a
zusätzliche Länge b	mm	1030	1055	1028	1215 bis/to 1230	additional length b

* zulässiger durch Freischaltkupplung abgesicherter Wert; effektiv steht max. die Schneidmotorleistung von 200 bzw. 230 kW zur Verfügung.
* admissible value ensured by the overload shifting clutch; effectively, a maximum cutting motor power of 200 or 230 kW is available.



Unterkante Maschinenrahmen
Bottom edge of underframe

Auslegungsbeispiel EDW-300-L / Example EDW-300-L

GN/3000/DE/4/87

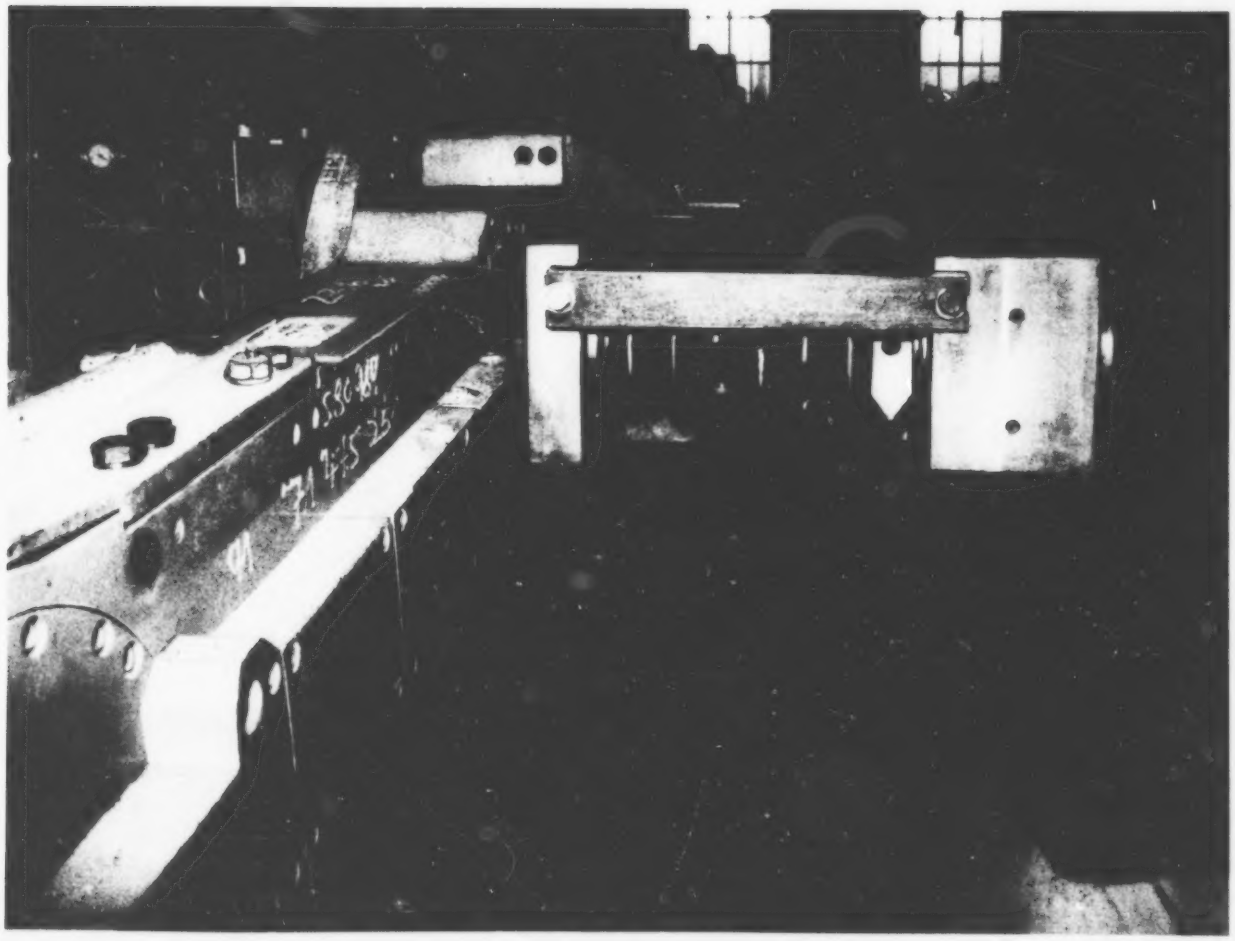
Eickhoff-Zusatzwalze für die Walzenlader-Baureihen EDW-170-LN, EDW-200/230-LN und EDW-300-LN

Eickhoff Lump Breaker for the Shearer Loader Series EDW-170-LN, EDW-200/230-LN and EDW-300-LN

Gebr. Eickhoff
Maschinenfabrik u. Eisengießerei mbH
Postfach 10 06 29, Hunscheidtstraße 176
D-4630 Bochum 1
Telefon (02 34) 77 71-1
Teletex 234 318 eick
Telex 17 234 318 eick
Telefax (02 34) 77 71-477
Telegramme Eickhoffwerk

Die Zusatzwalze ist stirnseitig an der Fördereinlaufseite des Doppelwalzenladers angeordnet. Sie zerkleinert das Fördergut vor dem Maschinenportal und verhindert so Maschinenstillstände, die durch Förderstau hervorgerufen werden können.
Die Zusatzwalze wird vom Schrämmotor des Walzenladers angetrieben und ist für die volle Schrämmotorleistung ausgelegt.

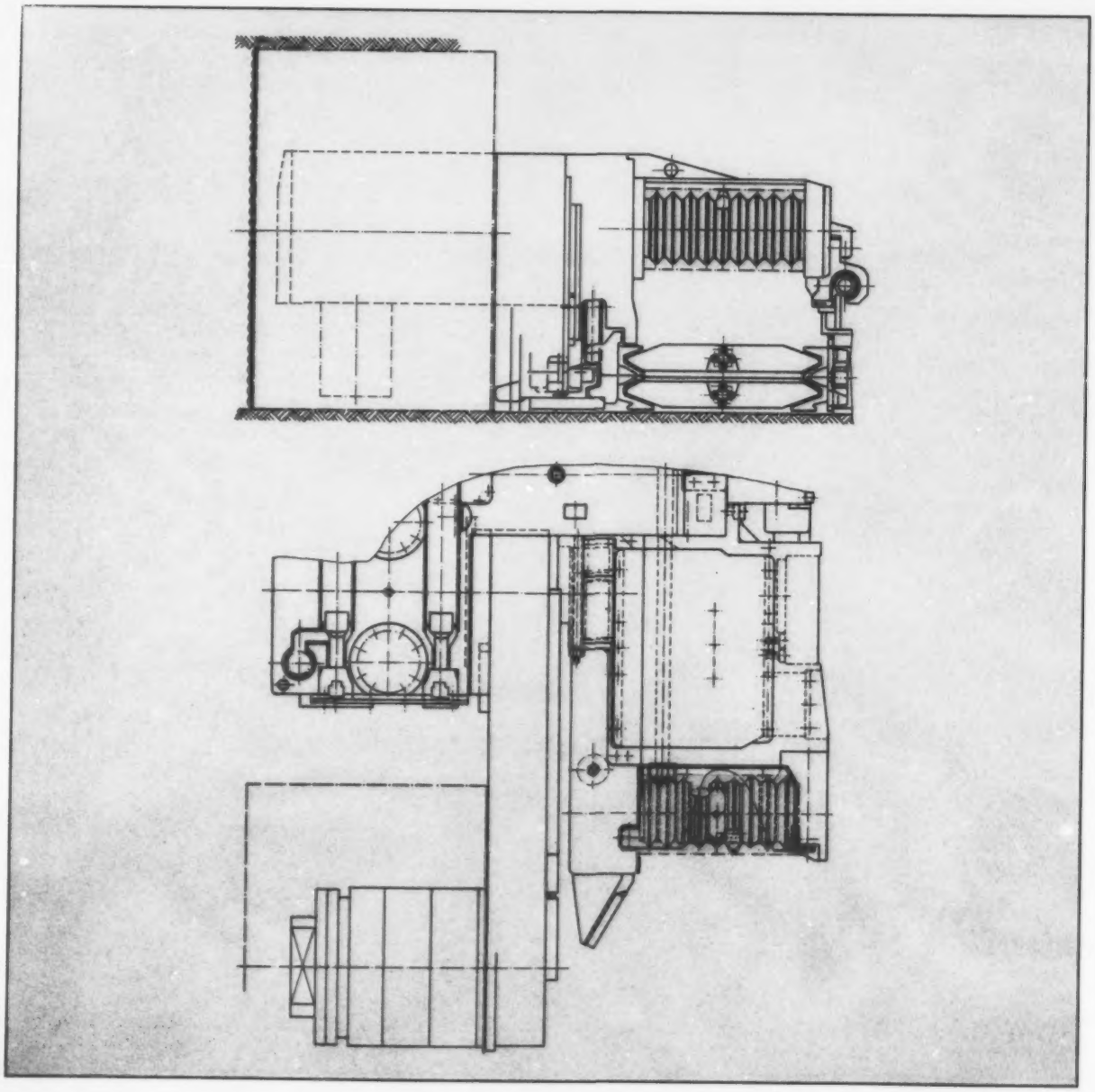
The lump breaker is mounted to the front side of the double-ended ranging drum shearer loader where the conveying material enters the clearance underneath the machine. It crushes the conveying material and therefore prevents machine stoppages due to large lumps and slabs.
The lump breaker driven by the shearer motor is designed for the full shearer motor power.



Die Zusatzwalzen der drei Niedrigwalzenlader-Baureihen EDW-170-LN, EDW-200/230-LN und EDW-300-LN sind beidseitig starr gelagert und so konstruiert, daß die gesamtinstallierte Schrämmotorleistung über den Walzentragarm voll übertragen werden kann. Die Zusatzwalze läßt sich über die Getriebekupplung im Walzenkopf ein- und auskuppeln.

The lump breakers of the three floor-based shearer loader series EDW-170-LN, EDW-200/230-LN and EDW-300-LN are rigidly supported on both sides and are designed such that the total shearer motor power installed can be fully transmitted to the ranging arm. The lump breaker can be engaged and disengaged by the gear clutch in the gearhead.

Technische Daten		EDW-170-LN	EDW-200/230-LN	EDW-300-LN	Technical Data
Leistung	kW	170	230	300	power
Drehzahl (50 Hz)	min^{-1}	280	300	301	drum speed r.p.m.
Schnittgeschwindigkeit	m/s	4,4	4,7	4,4	cutting speed
Walzendurchmesser	mm	300	300	280	drum diameter
Walzenbreite	mm	450	450	540	drum width

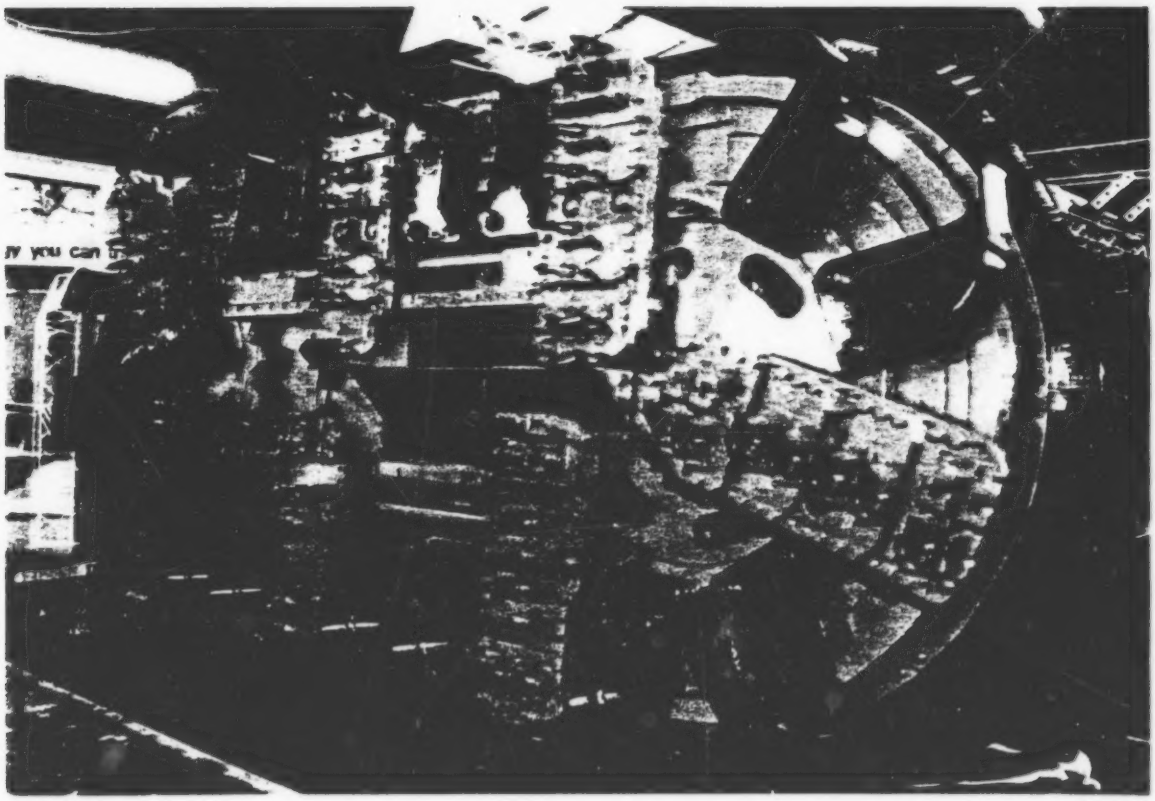


GN/3000/DE/4/87

DOSCO – M.R.D.E.

ISM 2000/3000

RAPID ENTRY DEVELOPMENT MACHINE



ISM 2000

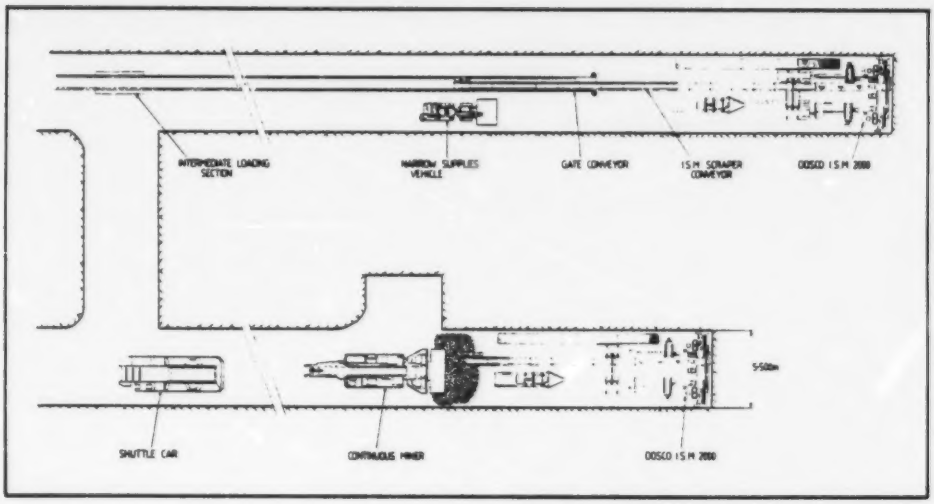
HIGH SPEED DRIVAGE WITH THE ISM2000

- **SIMULTANEOUS CUTTING AND BOLTING**
  bolt to within 500 mm of the face whilst the machine is cutting.

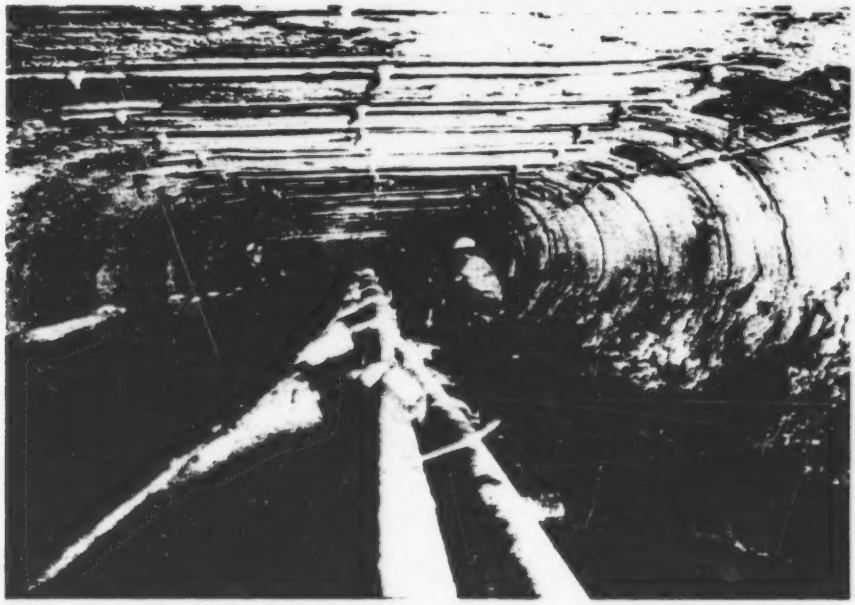
- **MULTIPLE BOLTING RIGS**
  Hand held or sledge mounted MULTIPLE bolters for fast, guaranteed support.

- **INCREASED SAFETY**
  Room to work and store materials
  No dangerous machine movements
  Stable profile and strong ribs
  Fixed width
  Low dust make
  Protection from falls of face

- **RELIABILITY**
  Simple design proven on 170 machines.



ISM Twin Entry



Finished Gateroad
(Driven with 1730mm ISM)

ISM2000 SPECIFICATION

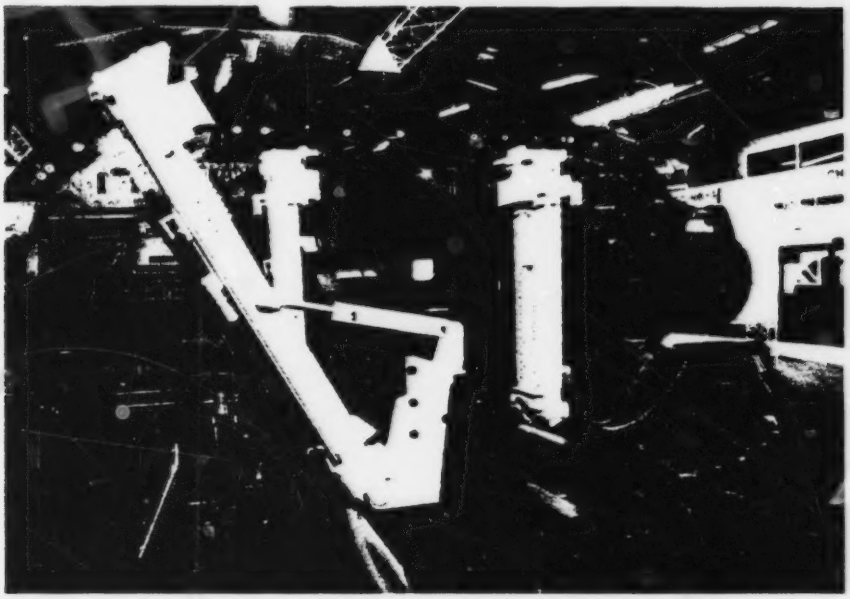
height range 1.8 m – 2.2 m

width range 4.7 m – 5.6 m (max)

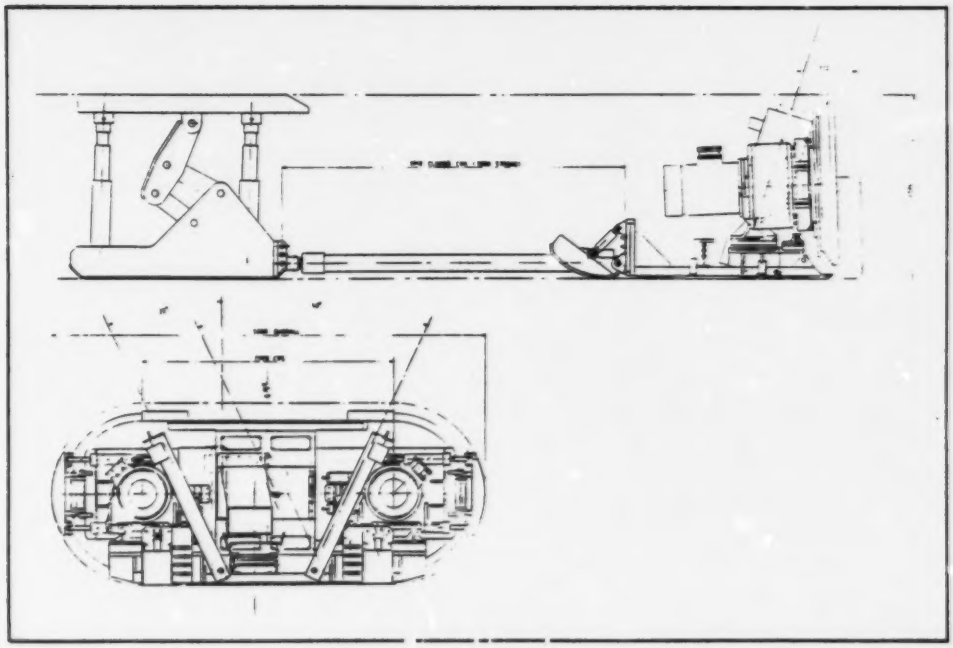
distance from face to closest bolt line vertical – 1.1 m
inclined – 0.5 m

cutter motors 2 x 45 kW

sustainable advance rate 9 m/hr (coal)



ISM 2000 with Fixed Rigs



ISM 2000

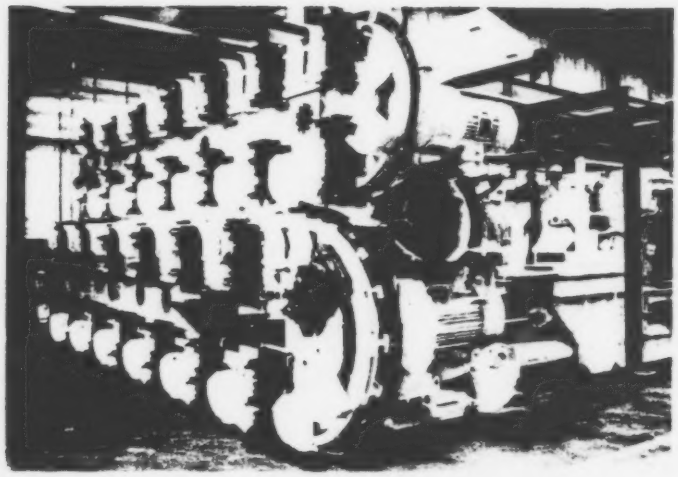
ISM3000 AT ELLALONG

A thick seam ISM, 3m high is being used to drive maingates for the Dowty longwall at Newcastle Wallsend's Ellalong Colliery in the Hunter Valley.

Operating in one or two parallel entries, the ISM3000 has averaged, over two gateroads, more than twice the shift advance rate of continuous miners used in the same application.

The finished gateroad has also proved more stable both in development and in the influence of the front abutment.

Using a Noyes designed and built roofbolting platform moving independently of the ISM3000, 4 fixed rigs can be operated whilst simultaneously cutting and loading.



ISM 3000

Ellalong Maingate

HAWKER SIDDELEY

DOSCO OVERSEAS ENGINEERING LTD

OLLERTON ROAD, TUXFORD, NR NEWARK, NOTTINGHAMSHIRE, ENGLAND TEL TUXFORD 870621 TELEX 56252

THE DOSCO CORPORATION P.O. Box 227, Intersection Routes 609/704, Abingdon, Virginia 24210 U.S.A.
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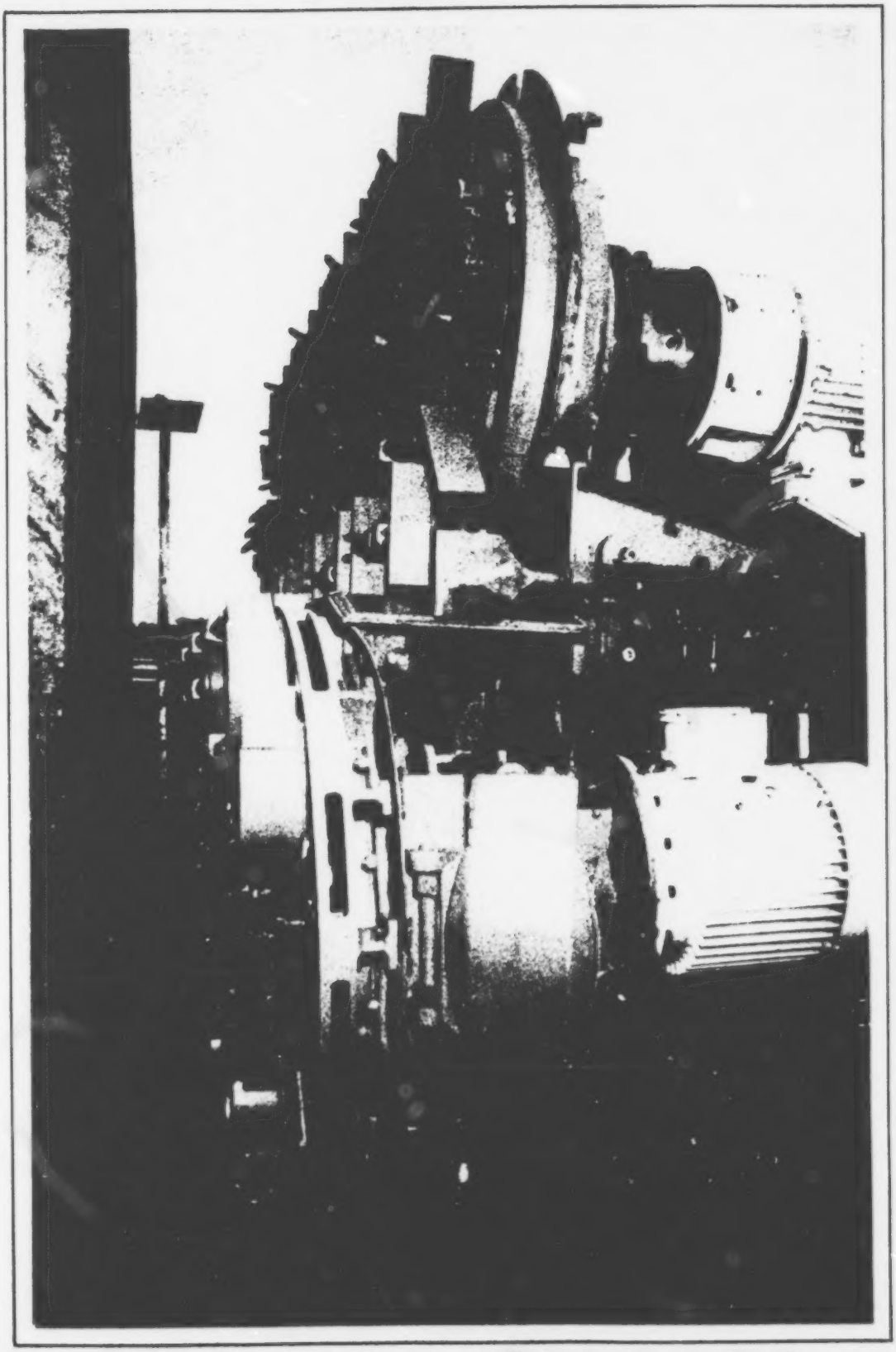
DOSCO



ISM 2000-ISM 3000

DOSCO IN-SEAM MINER

– RAPID ENTRY DRIVEAGE MACHINE.

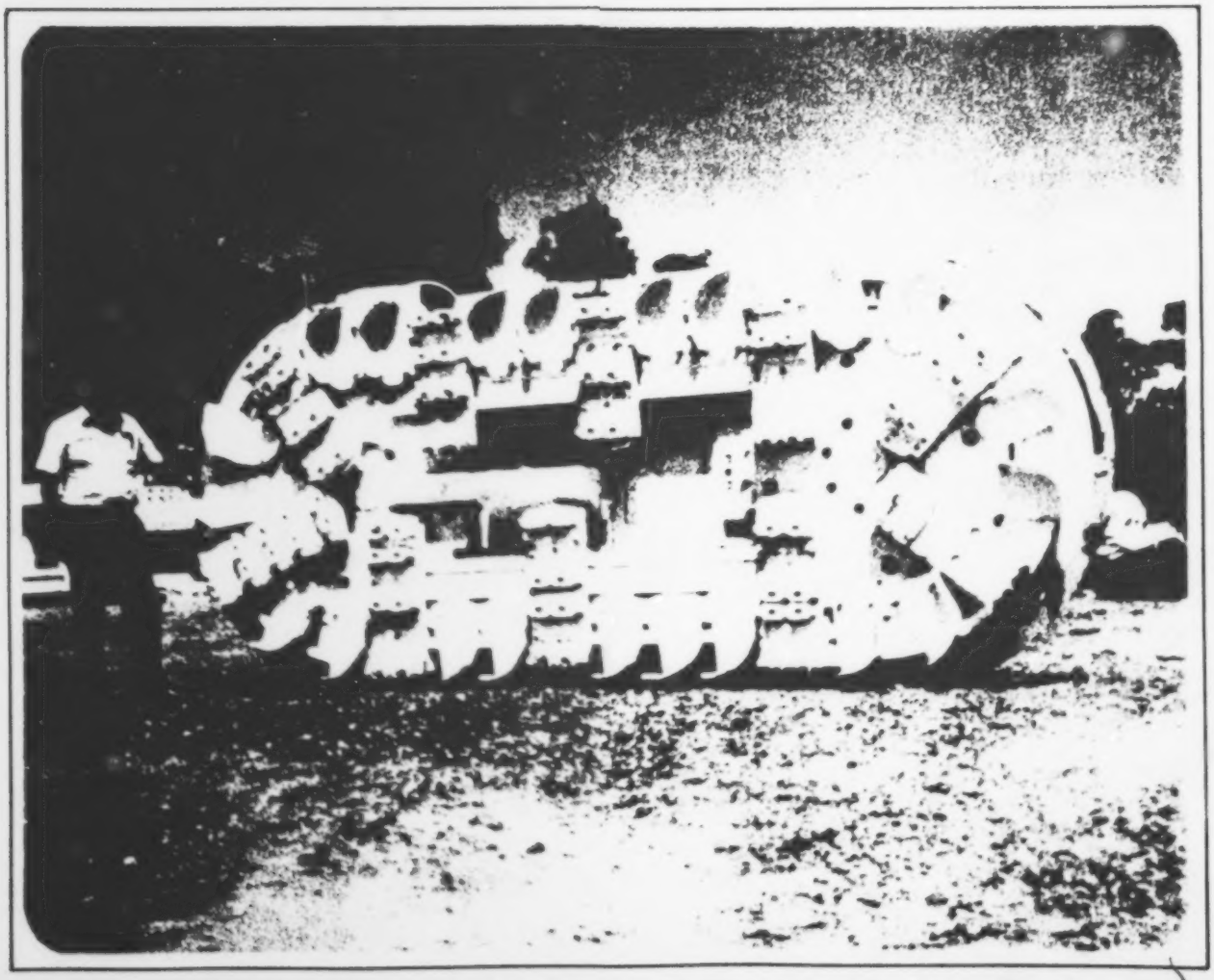
Dosco can now offer the ISM in height ranges from 860 mm to 3,150 mm extending its use into longwall and main development.

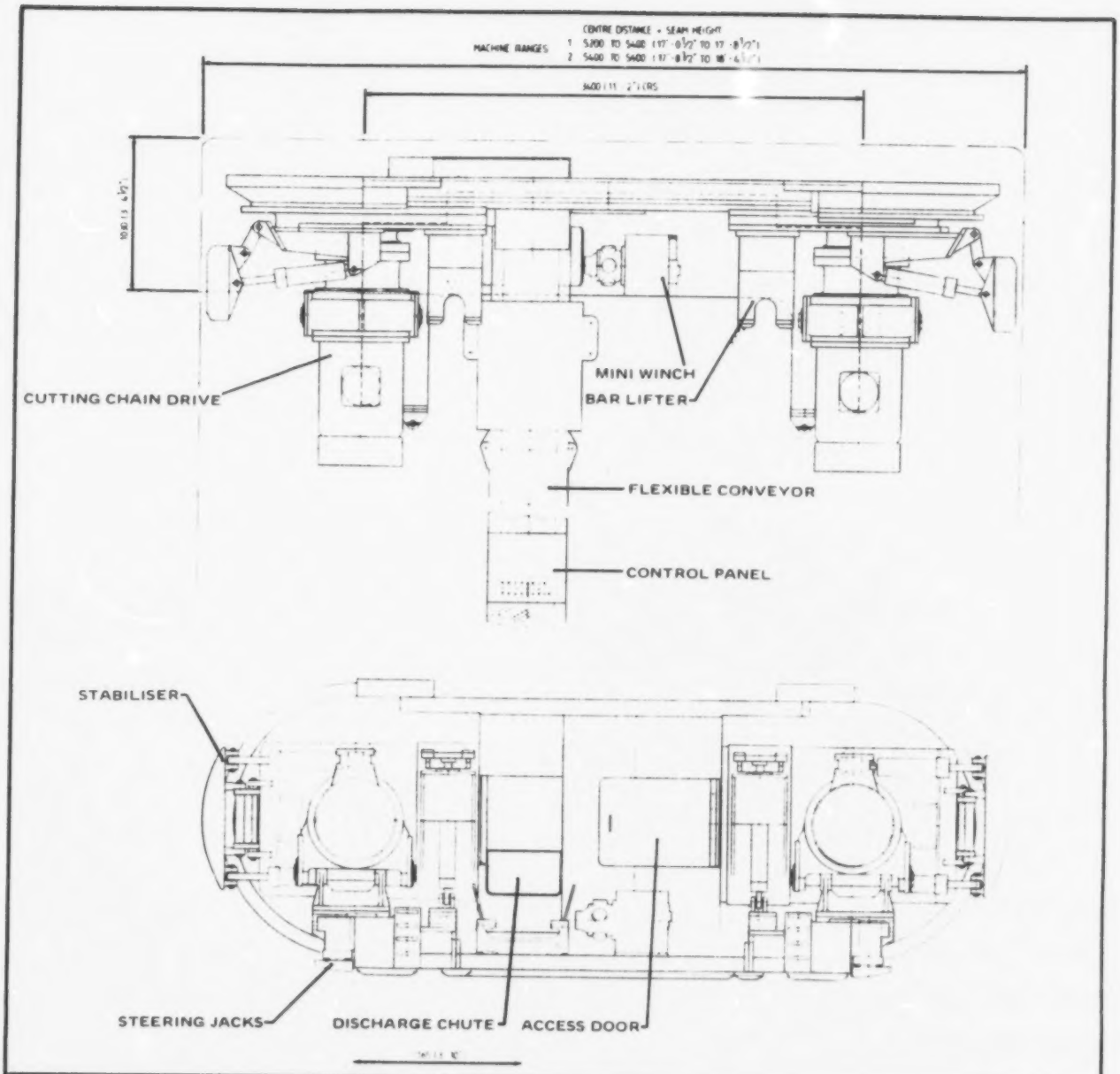
The well proven concept of the ISM offers:

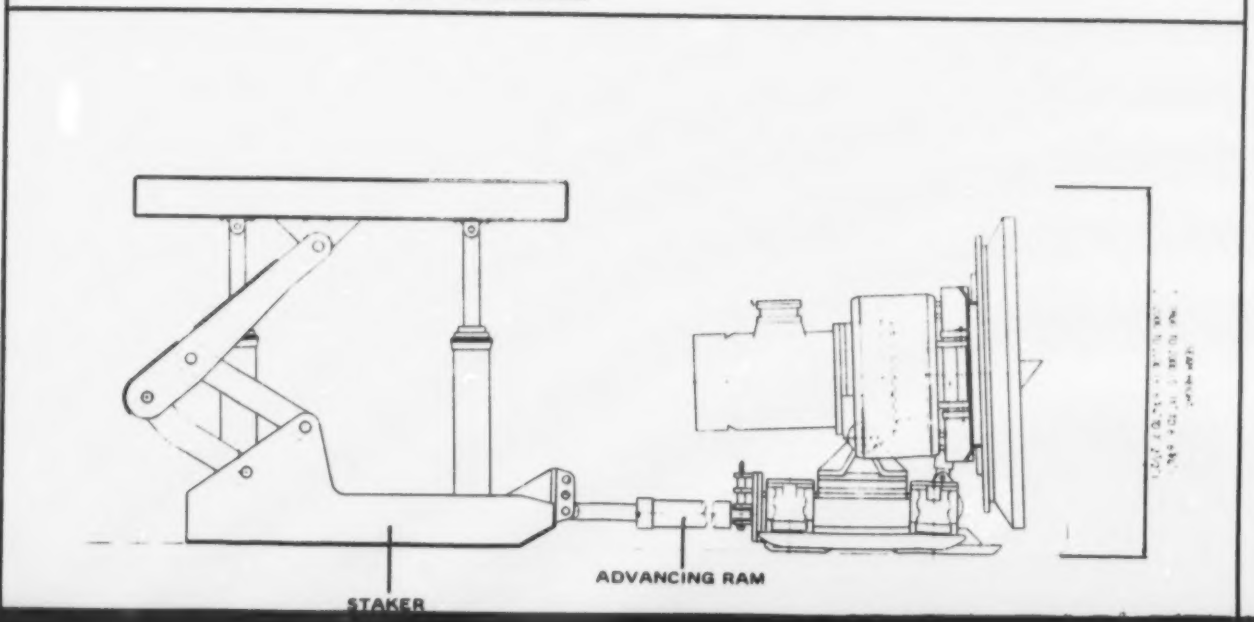
- continuous operation
- simultaneous cutting and roof support erection
- permanent supports 1,000 mm from face
- Stable and fixed profile
- protection from falls of face
- high availability
- low maintenance.

ISM 2000 Single Jib Machine

- 1,800 mm – 2,200 mm cutting height
- 90 kw continuously rated cutter motors

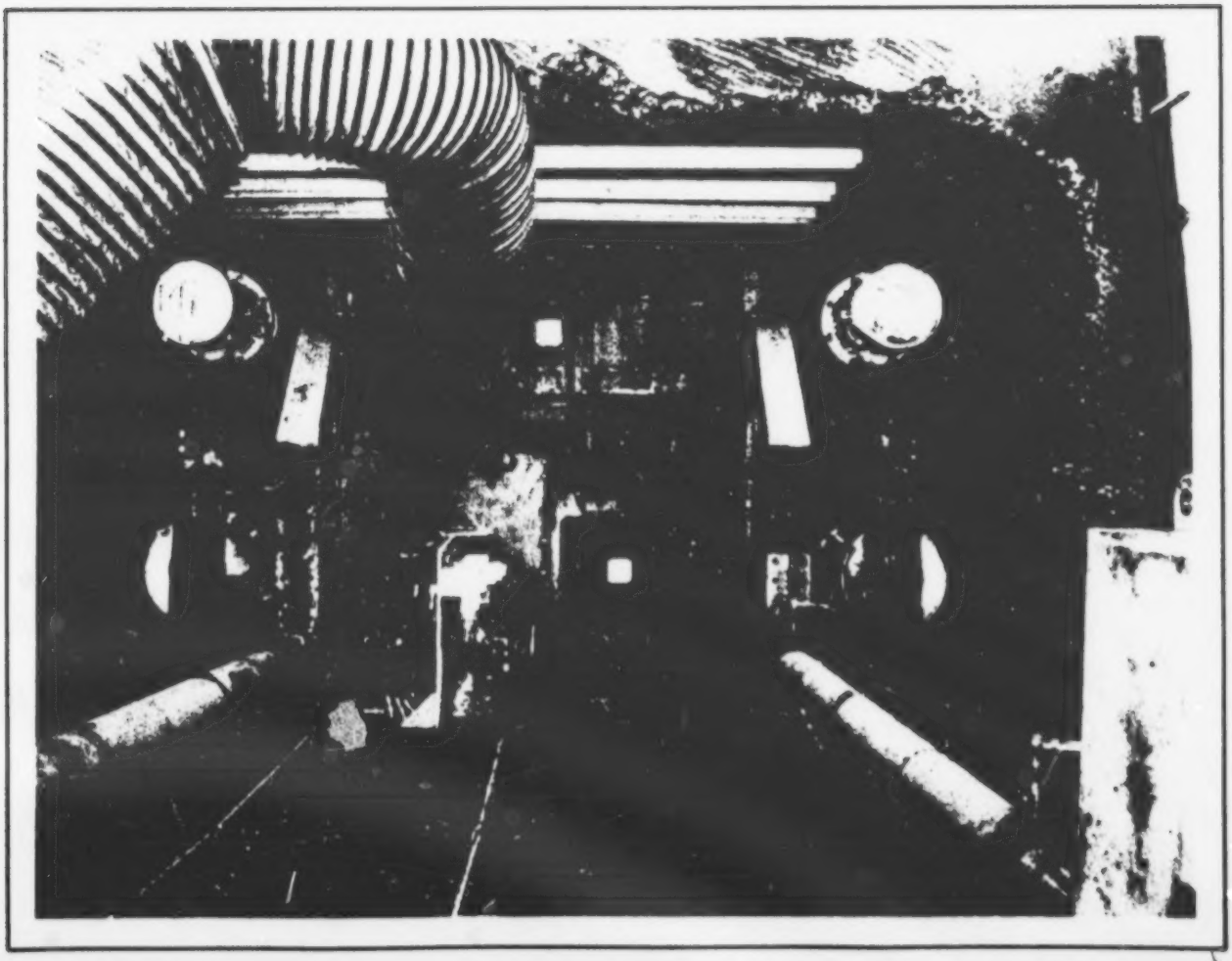


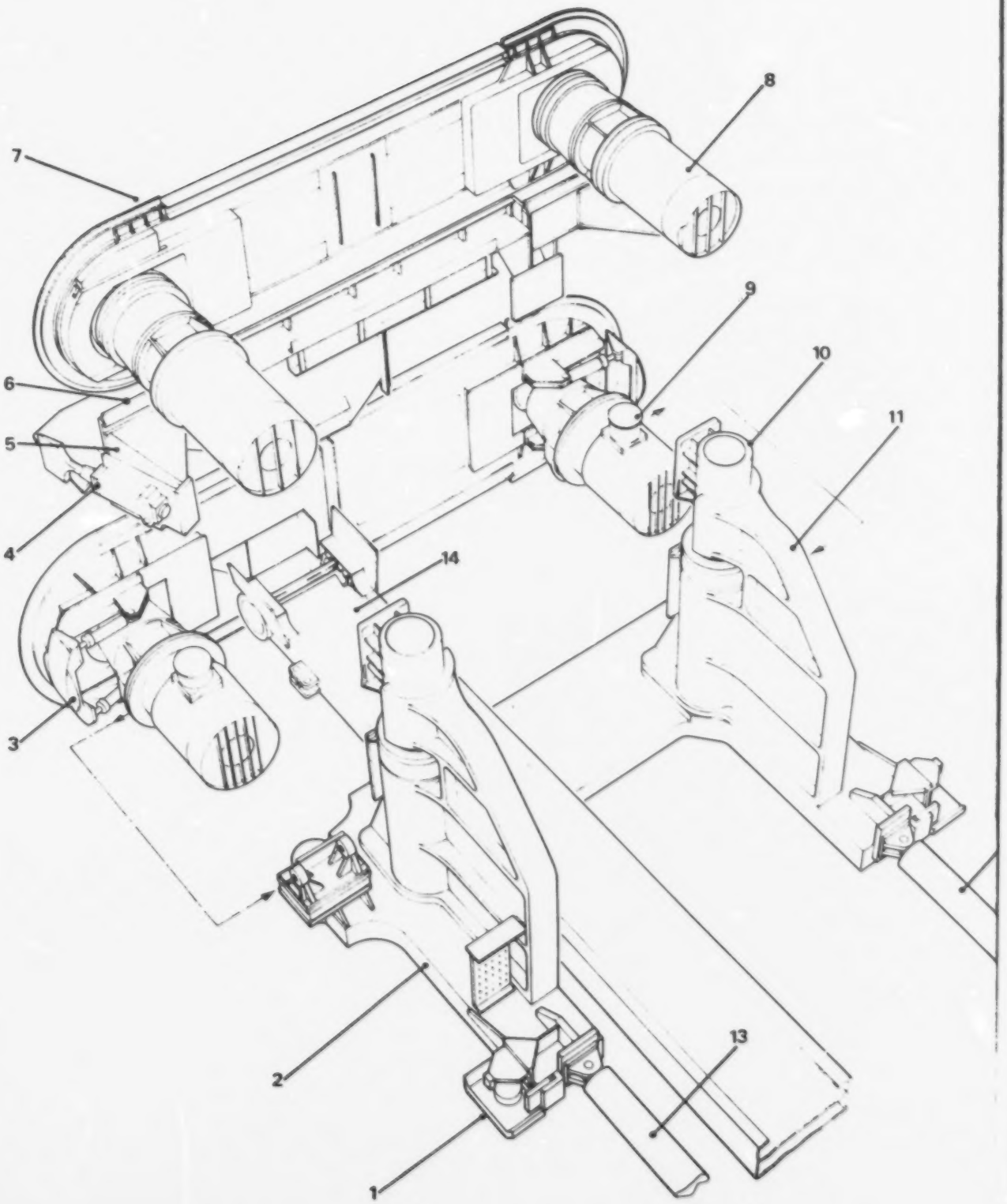

CENTRE DISTANCE + SEAM HEIGHT
MACHINE RANGES
CUTTING CHAIN DRIVE
MINI WINCH
BAR LIFTER
FLEXIBLE CONVEYOR
CONTROL PANEL
STABILISER
STEERING JACKS
DISCHARGE CHUTE
ACCESS DOOR


STAKER
ADVANCING RAM

ISM 3000 Double Jib Machine

- 2,500 mm – 3,150 mm cutting height
- 164 kw continuously rated cutter motors
- Rotary or Impact Cusp tools




1
2
3
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14

Item	Component	Length (m)	Height (m)	Width (m)	Weight (kg)
1	Steering jacks.	0.42	0.38	0.36	118
2	Mainframe base.	2.92	0.65	4.53	6700
3	Bottom jib LESS drive motors.	1.00	1.57	5.39	7880
4	Hydraulic hammer with chisel and back plate.	1.30	-	-	232
5	Hammer bracket.	1.12	0.35	0.60	225
6	False floor LESS hammer brackets.	0.70	1.33	4.22	1000
7	Top jib LESS drive motors.	1.00	1.42	4.42	5900
8	Top jib motor.	0.82	0.71	0.55	500
9	Bottom jib motor.	0.86	0.86	0.66	760
10	Top frame tube.	2.18	0.58	0.51	1000
11	Support column.	1.82	2.27	0.60	2100
12	Advance/retract cylinder (200 mm bore).	4.05	0.23	0.23	625
13	Advance/retract cylinder (250 mm bore).	4.05	0.30	0.30	740
14	Conveyor return end.	2.15	0.63	1.04	
15	Conveyor drive section and gearbox (LESS drive motor).	1.75	0.50	1.35	1900
Not Shown	Conv. motor (similar to top jib).	0.82	0.71	0.55	500
Not Shown	Staker chock.	2.60	2.10	0.90	4500

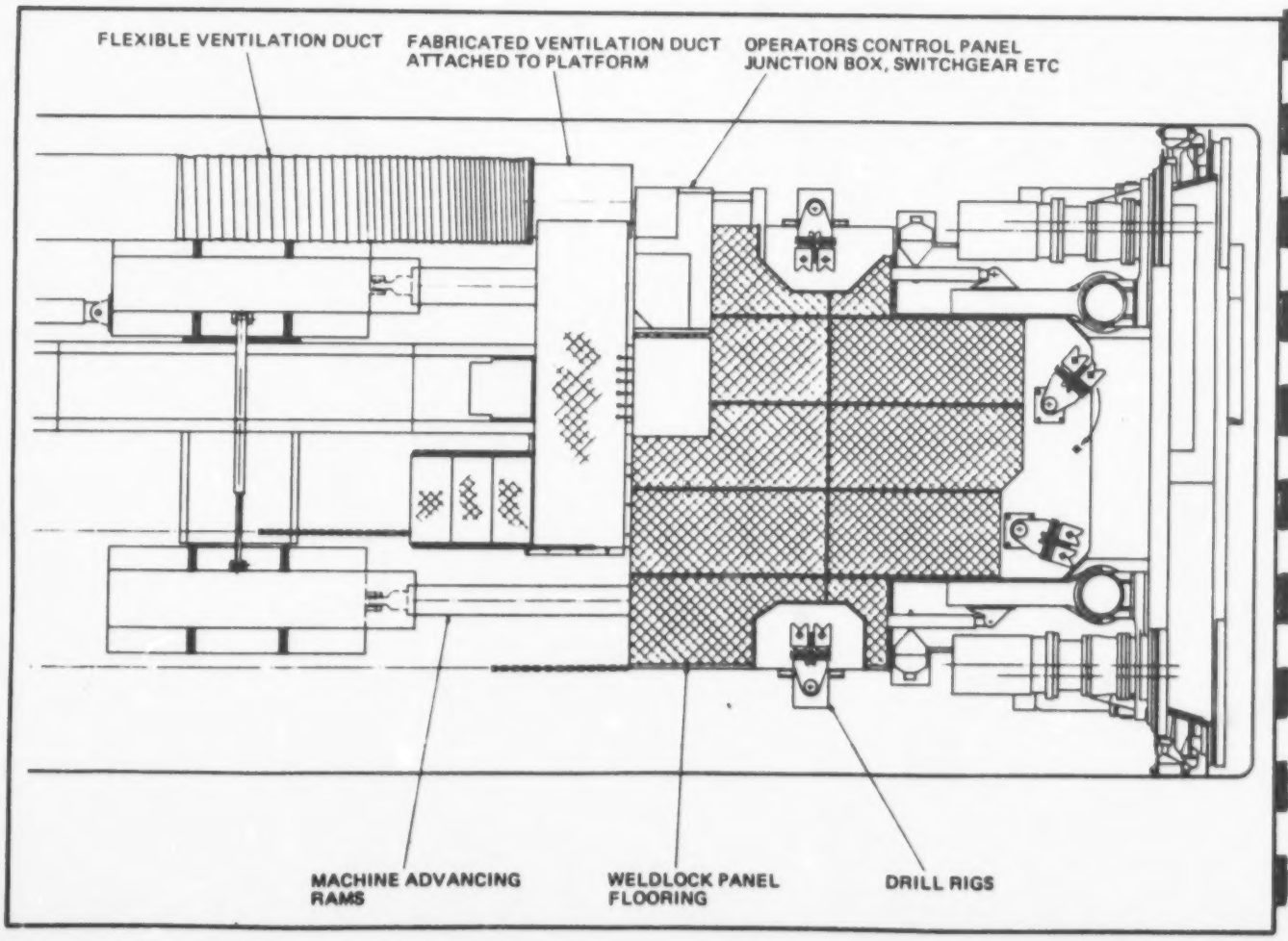
NOTE:

The weight of the complete machine, LESS pushing cylinders, staker chocks and control panel is approximately 28 250 kg.

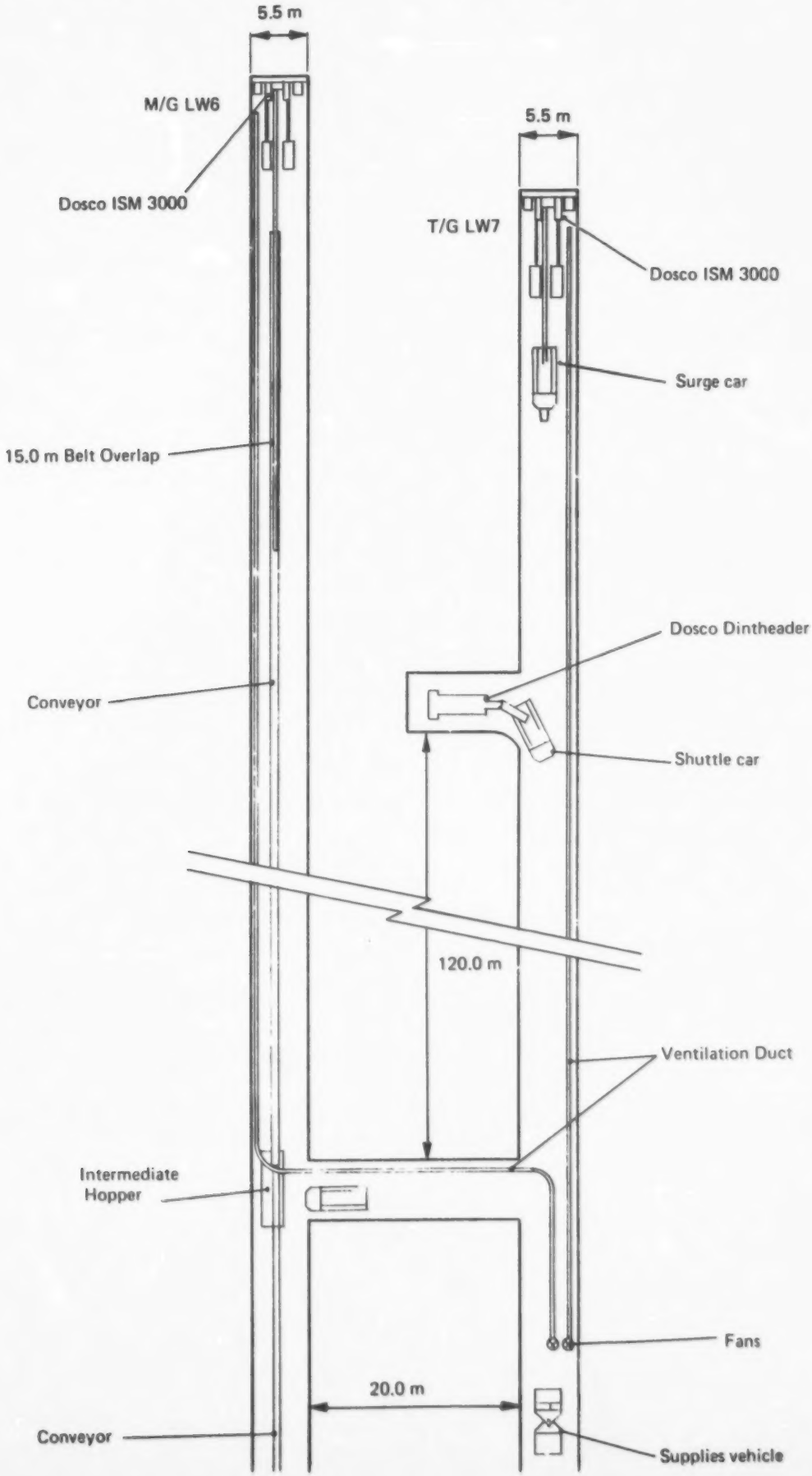
Systems for Total Mechanisation

We offer a total design and manufacture capability, including:

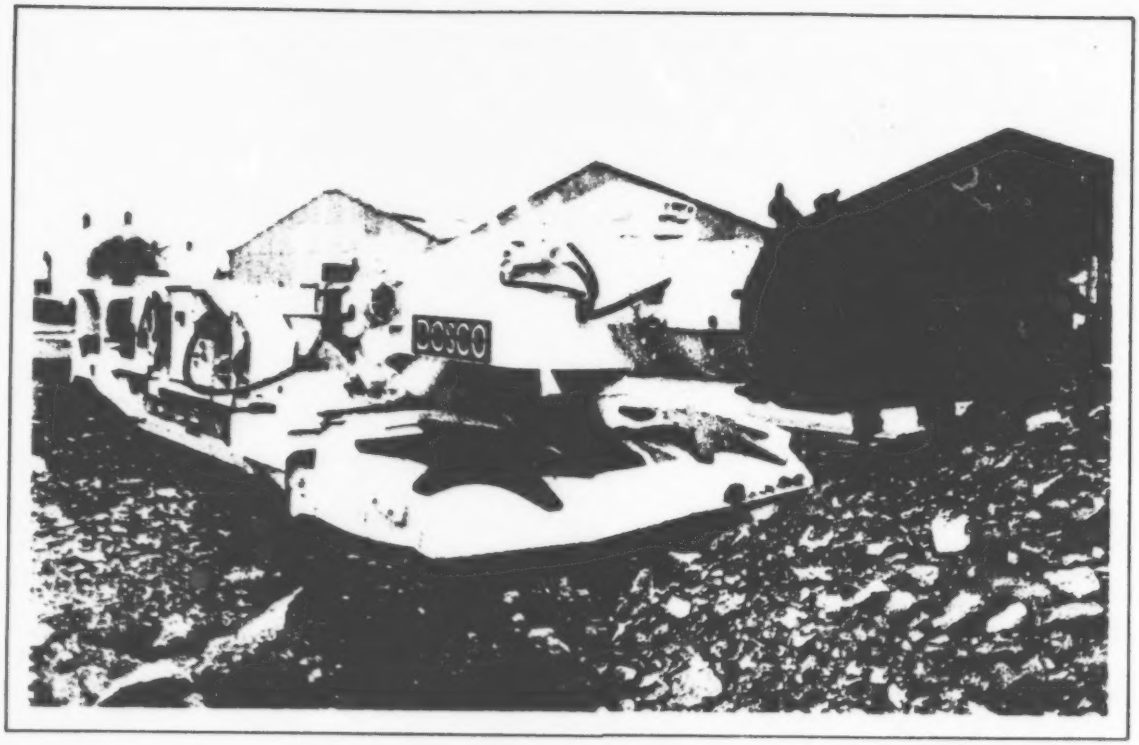
- support platforms
- roof bolters
- bar/arch setters
- Rib bolters
- vertical/horizontal anchor stations
- hydraulic power packs
- FLP electrical systems
- integral ventilation systems
- PLC operating systems
- nucleonic horizon sensors
- service and spares
- turnkey single entry and twin entry packages.



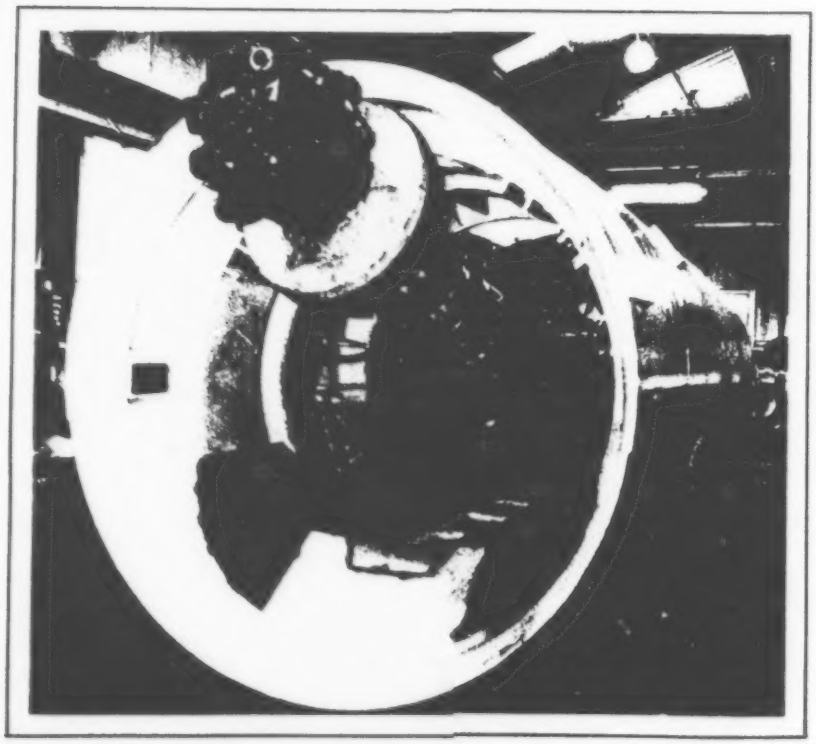
Twin Entry Longwall Development



OTHER EQUIPMENT IN OUR RANGE



Roadheading Machines



Circular Tunnelling Machines

HAWKER SIDDELEY

DOSCO OVERSEAS ENGINEERING LTD

OLLERTON ROAD, TUXFORD, NR. NEWARK, NOTTINGHAMSHIRE, ENGLAND. TEL: TUXFORD 870621. TELEX 56252

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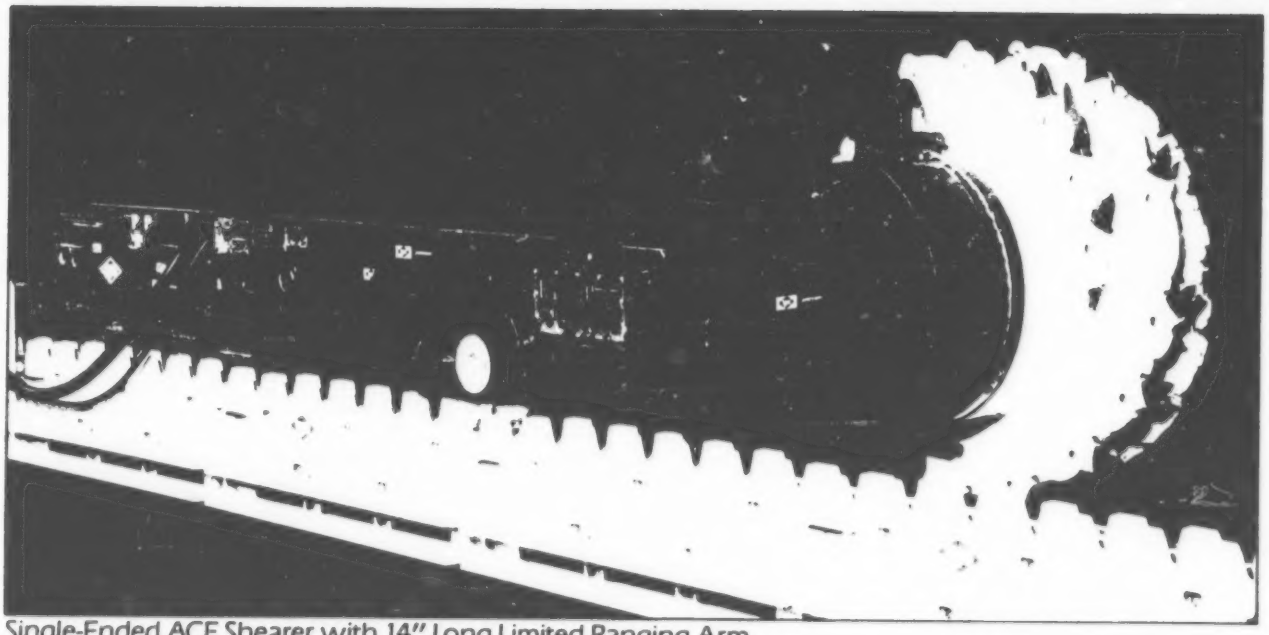
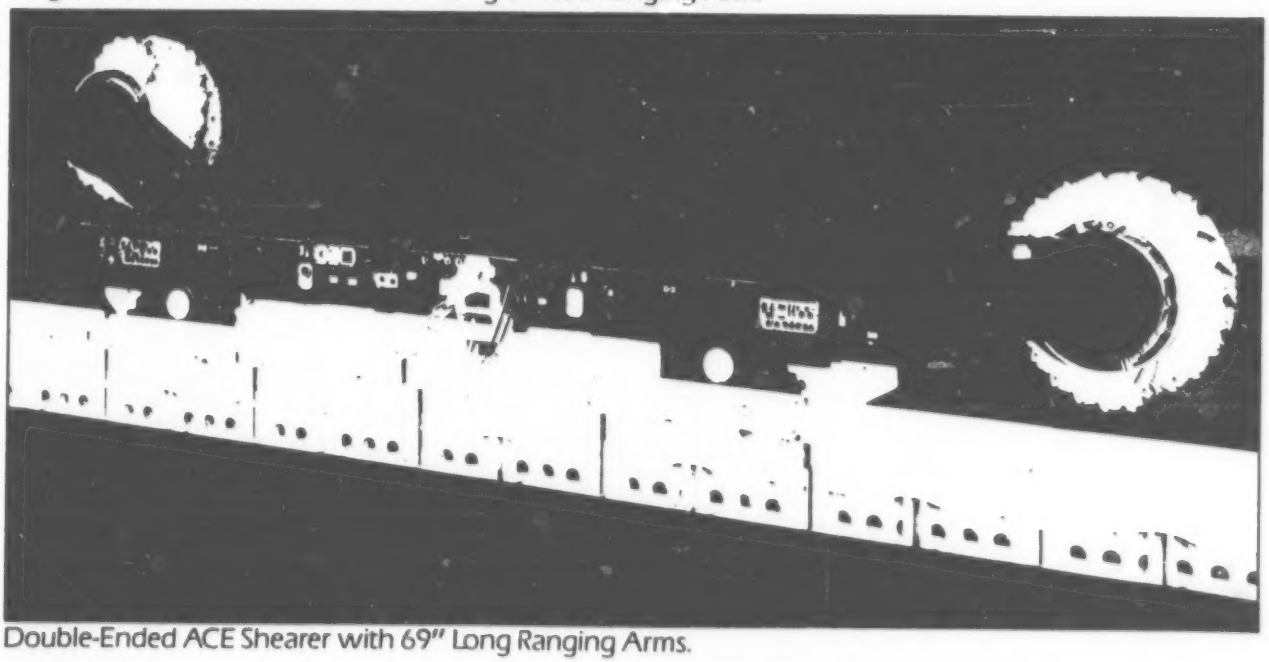
DRESSER™
500hp ACE Shearer-

Advanced Technology for High Performance Longwall Operations down to 50"



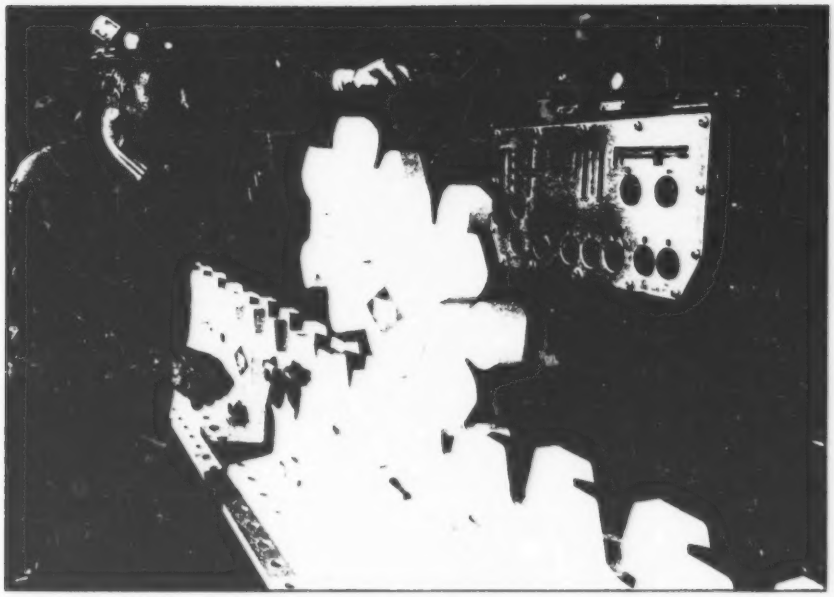
Single-Ended ACE Shearer with 14" Long Limited Ranging Arm.



Double-Ended ACE Shearer with 69" Long Ranging Arms.

DRESSER
Construction & Mining Equipment

Microprocessor Control and Health

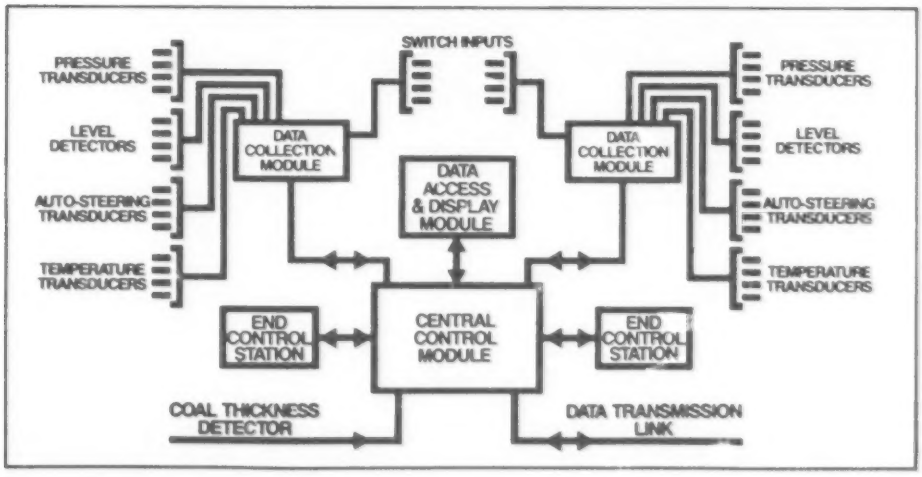


500 hp ACE Shearer with Dresser Multidrive Chainless Haulage.

Features of the ACE Shearer

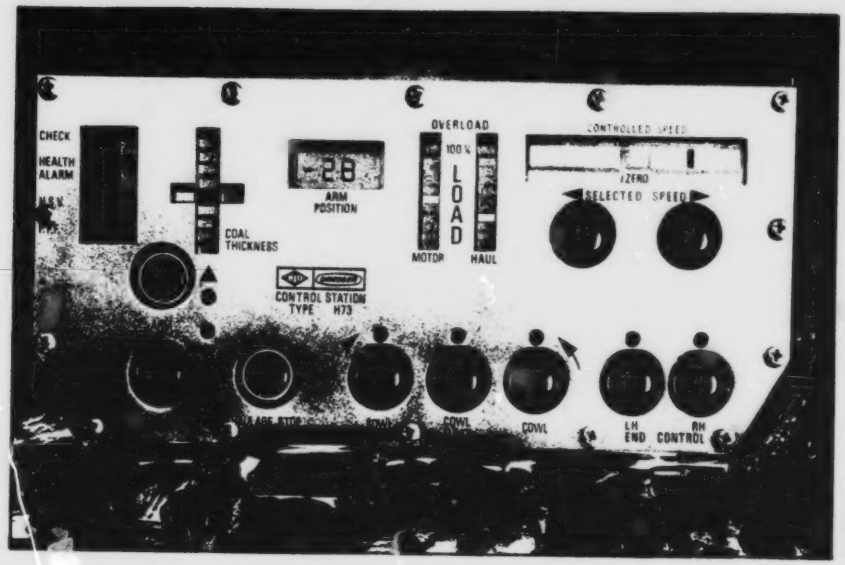
- 500 hp (60 Hz) Continuous rating.
- Designed for chainless haulage.
- Short machine body.
- Applications down to 50".
- Single or double ended machines.
- Haulage pulls up to 50 tons (D.E.R.D.S.).
- Fully automatic load sensing and control.
- Haulage speed up to 33 f.p.m.
- Push button end station control.
- Microprocessor control and Health monitoring.
- Data Access and Display Unit.
- Remote data transmission.
- Automatic horizon control system.
- Radio control system.

- **Full MSHA Approval**



Machine Control and Health Monitoring System

Monitoring

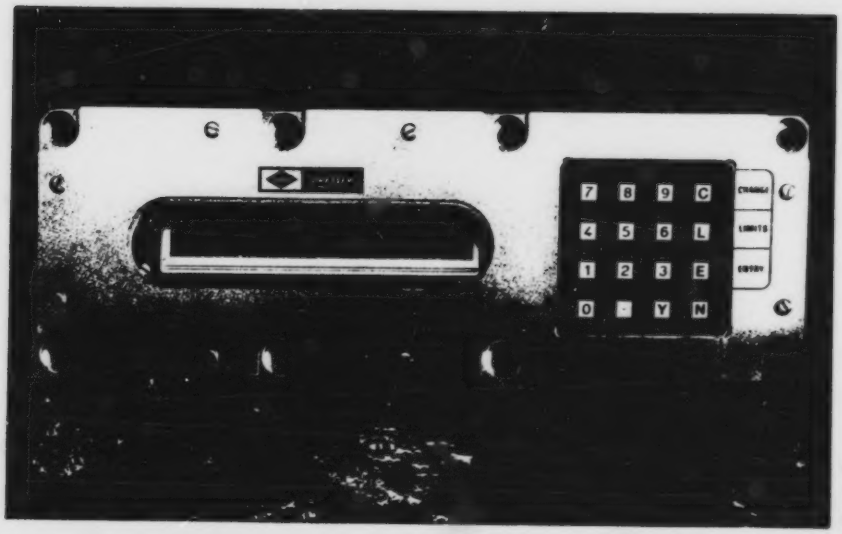


Operator's End Station Control Unit

End Station Control Unit Provides:

Push button operation of: Machine speed and direction, arm ranging and cowl movement.

Visual indication of: Motor load, haulage load, machine speed, arm position, machine health condition, Hollow Shaft Ventilation (HSV) and Pick Face Flushing (PFF) dust control systems.



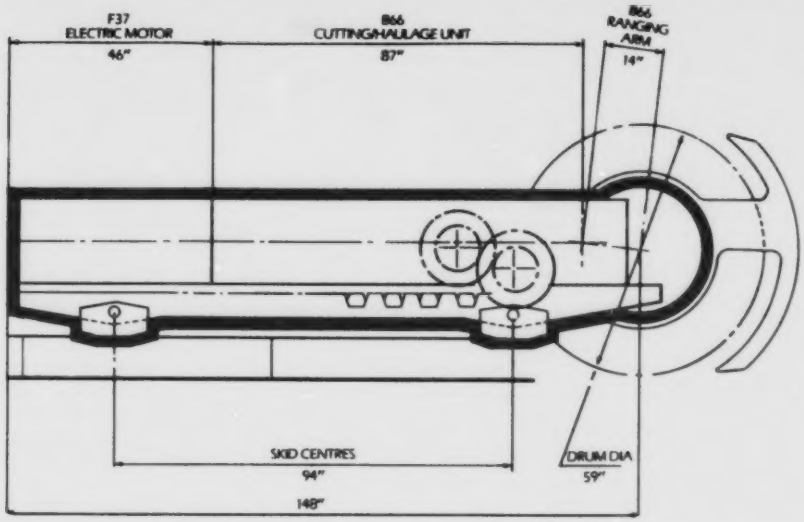
Data Access and Display Unit

Data Access and Display Unit Provides:

Information via transducers on: Hydraulic pressures and flows, oil levels, temperatures, internal power supplies and motor current.

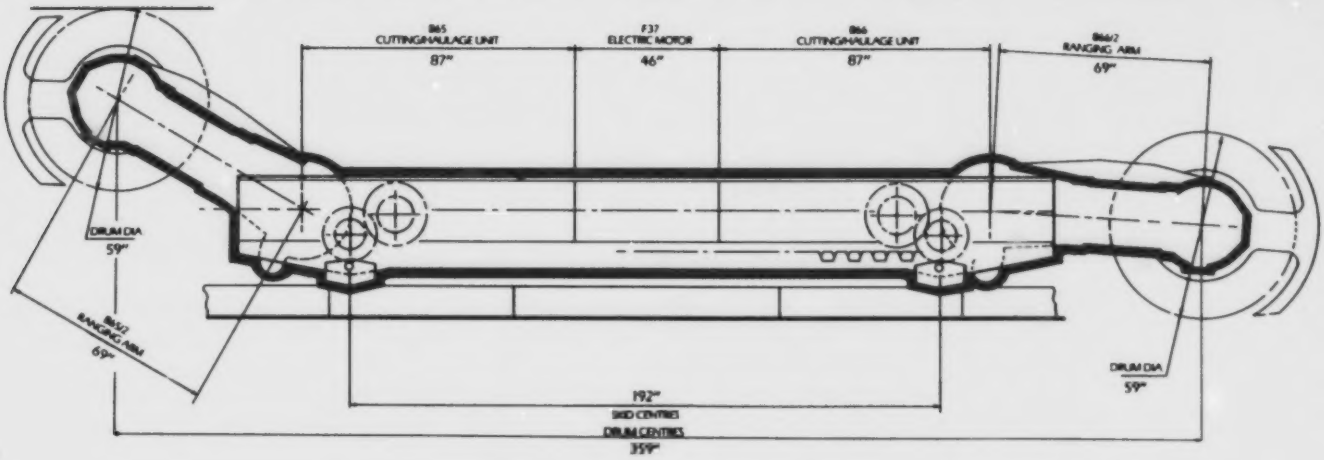
Fault diagnosis: Automatic, with built-in interrogation facility.

Typical Single-Ended ACE Shearer Arrangement



- Short length machine with only one joint.
- Full machine enters roadway.
- Suitable for Miniwall application with rollercurve conveyor.
- Bi-directional operations with elimination of complicated face-end manoeuvres or stables.
- Suitable for thin/medium seam extraction.

Typical Double-Ended ACE Shearer Arrangement



- Choice of arm length for different applications.
- Suitable for medium/thick seam extraction.

Jeffrey Division
Dresser Industries Inc
P.O. Box 1879
Columbus, Ohio, 43216
Phone: (614) 297-3123
Telex: 433-4014

DRESSER INDUSTRIES DRESSER

DRESSER

Construction & Mining Equipment

Publication No.
16S4187USA

Anderson Strathclyde PLC

leaflet 20-130

Anderson

AM500

shearers

This series of powerful, robust machines was developed to meet the demand for ever increasing power and reliability, essential qualities in longwall coalface machinery. The series is complimentary to the existing range of Anderson Strathclyde coalface power loaders and is presently producing high outputs from various coal seam thicknesses throughout the world. The high degree of reliability embodied in the machines of the series is a result of a policy of continuing improvement both in design and materials allied to the experience gained through manufacturing for the mining industry for over 80 years.

•ROBUST
•RELIABLE
•POWERFUL
•VERSATILE

Features of the Series:—

Suitable generally for seam thicknesses 1.5m (5') to 5m (16'-6").
Lower seam heights can be worked with particular arrangements.
Single or double ended machines.
Applied power of up to 750kW (1000hp)
Single or double motor arrangements, 50Hz or 60Hz supply.
High pull haulage units for chain or chainless systems.
Single and 2-speed gearhead gearboxes provide a wide range of cutting drum speeds.
Outboard ranging arms for stable elimination, roadway ripping and dinting.
Combined pick face flushing dust suppression and hollow shaft venturi drum ventilation.
Radio control system available.
Micro-processor based machine diagnostic and health monitoring systems.
Gear driven powered cowls.
Robust underframe — roll steering or fixed.
Unit construction facilitates maintenance and spares economy.

Machine units

Fig. 1 *AM500 with chainless haulage showing unit arrangements available.*

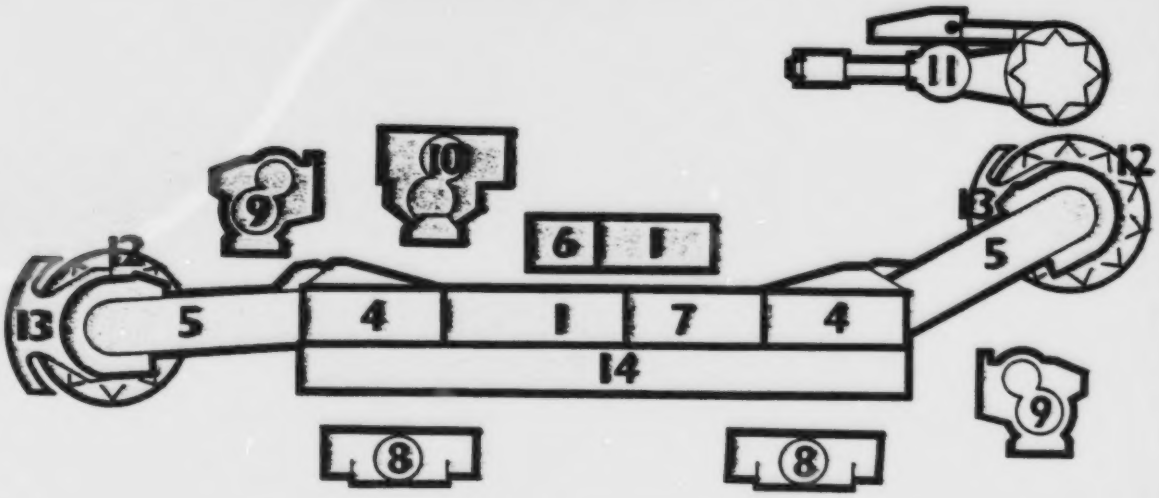


Table of Machine units

1. Electric motor (1 or 2)
2. Hydraulic haulage pump box (chain hauled machine)
3. Haulage gearbox (chain hauled machine)
4. Gearhead gearbox (all machines)
5. Ranging arm (outboard)
6. Adaptor box (with 2 motors) or radio control box
7. Power pack (chainless haulage machine only)
8. Underframe mounted chainless haulage traction unit
9. End mounted chainless haulage traction unit
10. Intermediate box for chainless haulage traction unit
11. Lumpbreaker (optional) on chain haulage and chainless machines
12. Cutting drums
13. Powered cowl
14. Underframe — roll steering or fixed — for chain haulage and chainless machines

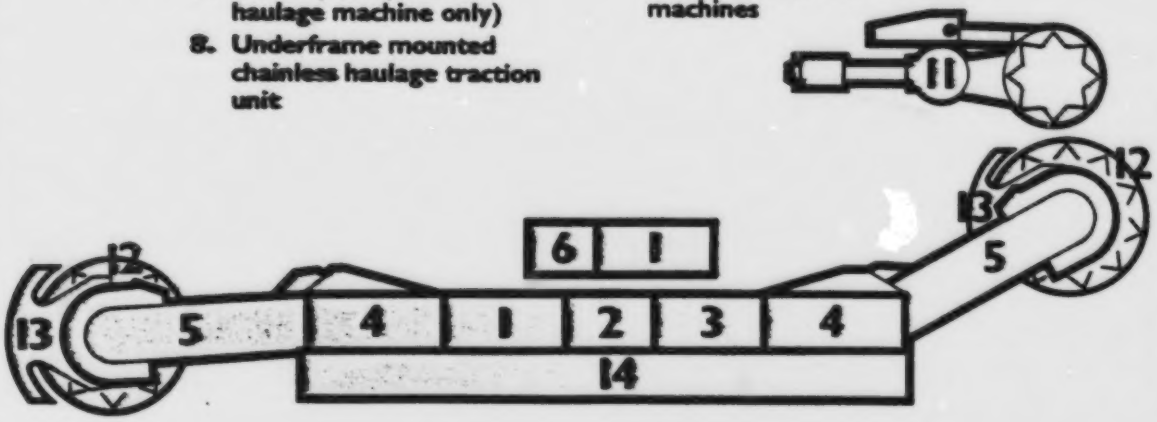


Fig. 2 *AM500 with chain haulage showing unit arrangements available.*

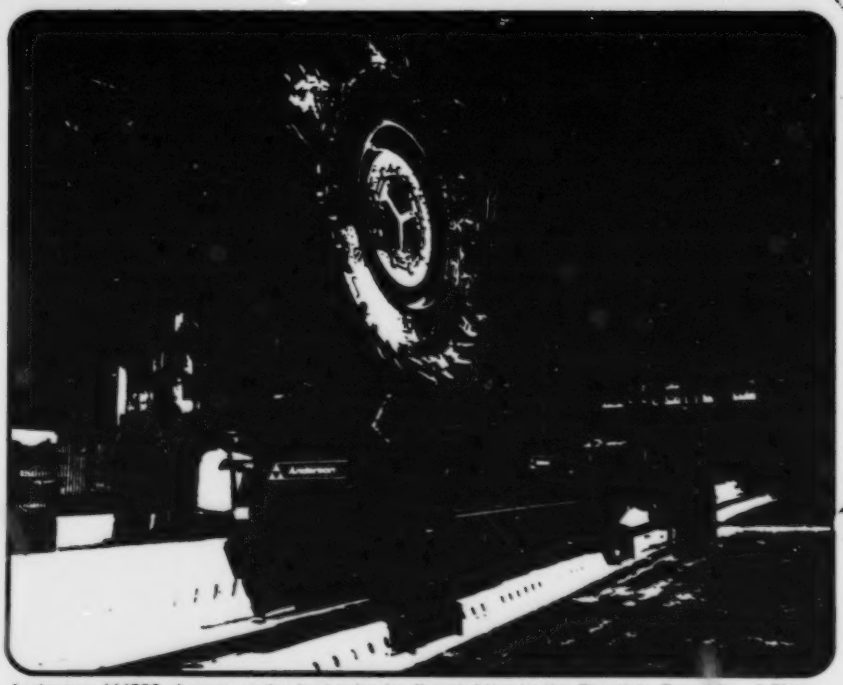
Major unit specification *(please see previous page)*

2KI Electric motor and switch unit (Unit 1)

The motor is 375kW or 300kW (500 or 400 hp), water-cooled with integral switch unit and cable entry and is suitable for use on supply voltages of up to 1200V, with a minimum voltage dependent on supply cable and switchgear. The switchbox incorporates a torque motor, forming part of the automatic haulage speed control system, also remote control and protection equipment for both motor and haulage circuits. An integral test switch is provided for electrical faultfinding.

A double motor, double cable arrangement is available and requires the use of an adaptor box (unit 6) between the motors. This may be non-flameproof or fitted with radio control as required. A power rating of up to 750kW (2 x 375kW) at up to 1200V is available with this arrangement.

A double motor, single cable arrangement is also available with a power rating of up to 750kW (2 x 375kW) at voltages of 3.3kV to 5kV at either 50 or 60 Hz. With this arrangement the incoming cable enters the machine through the flameproof adaptor box between the motors.



Anderson AM500 shearer under test prior to dispatching to the People's Republic of China.

Haulage units

Alternative machine arrangements allow the shearer to be fitted with Roll Rack or other chainless haulage systems, or with chain haulage for 22mm or 26mm chain.

Chain haulage *(see fig. 2)*

(Units 2 and 3)

The AM500 hydraulic haulage consists of the FH1 pump box (unit 2) and the FH2 gearbox (unit 3). The pump box houses the hydrostatic transmission which comprises an axial piston variable displacement pump, connected directly to a similar type of motor and forming a closed loop hydraulic circuit. The internal arrangements are such that the pump box is devoid of all gearing.

The valve and control equipment for the transmission unit are housed in a separate 'dry' compartment and the control valves for the auxiliary functions, such as underframe and ranging arm operation, are in a second 'dry' compartment. Pipe work has been kept to a minimum and the general layout facilitates inspection and maintenance. The hydraulics are fully protected from overheating, lack of priming pressure or excessive high pressure, and adequate gauges are provided so that the system can be continuously monitored.

An automatic speed control system is included which allows the maximum haulage speed to be preset manually, after which the auto control system will automatically regulate the speed according to the load on the electric motor.

The haulage gearbox (unit 3) houses the main pump drive which is taken through spur gearing from the electric motor shafting to the pump in the hydraulic haulage and returned from the hydraulic motor to the gearbox to power the reduction gearing leading to the drive sprocket.

The main pump gear train also drives a duplex pump which powers the auxiliary functions and the remote control push button stations. A small gear pump provides lubrication for gears and bearings within the haulage gearbox.

The haulage is fitted with sprockets to suit either 22mm or 26mm haulage chain depending on the maximum pull required (face requirements).

The haulage for 22mm chain has a maximum haulage pull of 27.4 tonnes (27 tons) at speeds up to 6.8 metres (22 feet) per minute. A maximum haulage speed of 12 metres (39 feet) per minute allows pulls of up to 14.9 tonnes (14.7 tons). This haulage has a maximum operating pressure of 140 bar (2000 psi).

The haulage for 26mm chain has a maximum haulage pull of 36.6 tonnes (36 tons) at up to 5.8 metres (19 feet) per minute. Its maximum haulage speed is 10.5 metres (35 feet) per minute at up to 21.3 tonnes (21 tons) pull and it has a maximum operating pressure of 173 bar (2500 psi).

Chainless haulage *(see fig. 1)*

The FH3 power pack (unit 7) supplies hydraulic power to motors in the traction units which may be underframe mounted (unit 8), or end-mounted, i.e. bolted to the end face of each of the gearhead gearboxes (unit 9), or located in an intermediate box (unit 10).

The power pack contains an axial piston variable displacement pump, driven by spur gearing taken from the through shafting of the electric motor to the gearhead gearbox, and is connected by flexible piping to the hydraulic motors of the traction units. A dry compartment is provided for valve gear, the protection systems for the hydraulics and the automatic speed control system as in the hydraulic haulage.

An alternative is the Selectronic control, an electronic control system which allows the maximum speed of the haulage to be pre-set electrically, either from end control stations or from radio control, after which the control system automatically regulates the machine speed to either the load on the electric motor or the hydraulic system pressure. Manual operation of the pump servo is provided for use in an emergency. A separate FLP compartment houses the electronic control system which contains a small electric servo motor coupled by linkages to the main pump servo mechanism and valve gear, and to pressure switches.

Traction units (Units 8, 9 and 10)

These are essentially gearboxes containing fixed displacement, high torque, low speed hydraulic motors driving, through spur gear train reductions, final drive shafts. For Roll Rack, each of these is fitted with a roller wheel designed to engage with the teeth on the rack bars. The wheel contains equally spaced hardened steel rollers, and a special rack cleaner is incorporated in the guard to keep the teeth free of obstruction. Standard and heavy duty traction units are available, together with a choice of hydraulic motors, which provide a wide range of speed and pull combinations.

Anderson AM500 shearer cutting coal on a longwall face in a British Colliery.
(Photo courtesy of the National Coal Board).

Low seam arrangement

For a lower seam arrangement each traction unit is end mounted, the roller wheel being positioned to suit the underframe height. Where an end mounted unit cannot be fitted, the roller wheel can be located on the side of an intermediate box within the shearer's configuration.

Alternative Systems

In addition to Anderson chainless haulage, other chainless systems can be driven by these traction units.

Machine controls and health monitoring

Controls

Where chain haulage is used, manual controls for the motor, haulage, and auxiliaries are located in a central position on the motor and haulage units. In addition, hydraulic push-button assemblies can be fitted at each end of the shearer, providing remote control of machine functions. A low pressure system provides control of auxiliaries and haulage stop/start, or a high pressure system can be fitted for all functions except haulage speed and direction control.

When using chainless haulage with the power pack pre-set manually, only haulage speed and direction are controlled at the power pack. Hydraulic push-button stations at each end of the shearer, using a high pressure system, control the haulage stop/start and the auxiliaries.

Where the Selectronic control system is used, the haulage direction and speed are controlled from electric control stations located at each end of the machine, or by radio.

Diagnostic and health monitoring

The electric motor can be fitted with a micro-processor based pilot circuit diagnostic and health monitoring unit. This displays pilot circuit faults on an alpha numeric scrolling message; and power supply and relay monitoring indicators are also fitted. A monitoring unit can also be supplied, providing digital displays of the temperature of motor bearings, windings and cooling water.

A range of digital displays, LED and neon indicators, relay monitors and magnetic ball indicators can also be fitted to an intermediate box adjacent to the motor, as required. Functions monitored include current, voltage, speed, power supply and high and low oil pressures.

Radio Control

An integral radio control system is available, providing remote control of most machine functions for one-man or two-man operation.

Gearhead gearboxes
(Unit 4)

This unit houses the train of gears which takes the drive from the electric motor to the ranging arm.

The FH5 gearbox is a 2-speed design which provides the facility for changing the drum speed from fast, through neutral, to slow, the final reduction of variable ratio gears giving a full range of cutting drum speeds. High horsepowers can, therefore, be transmitted at low drum speeds and this helps to reduce the generation of dust.

Cutting drum speeds down to 19 rpm are available, depending on power, ranging arm and drum size required.

The FH21 gearbox has only a single speed facility and, consequently, has a simpler internal design contained in a shorter gearbox. This is of particular value where an intermediate traction unit is included and when a minimum machine length is necessary.

Ranging arm
(Unit 5)

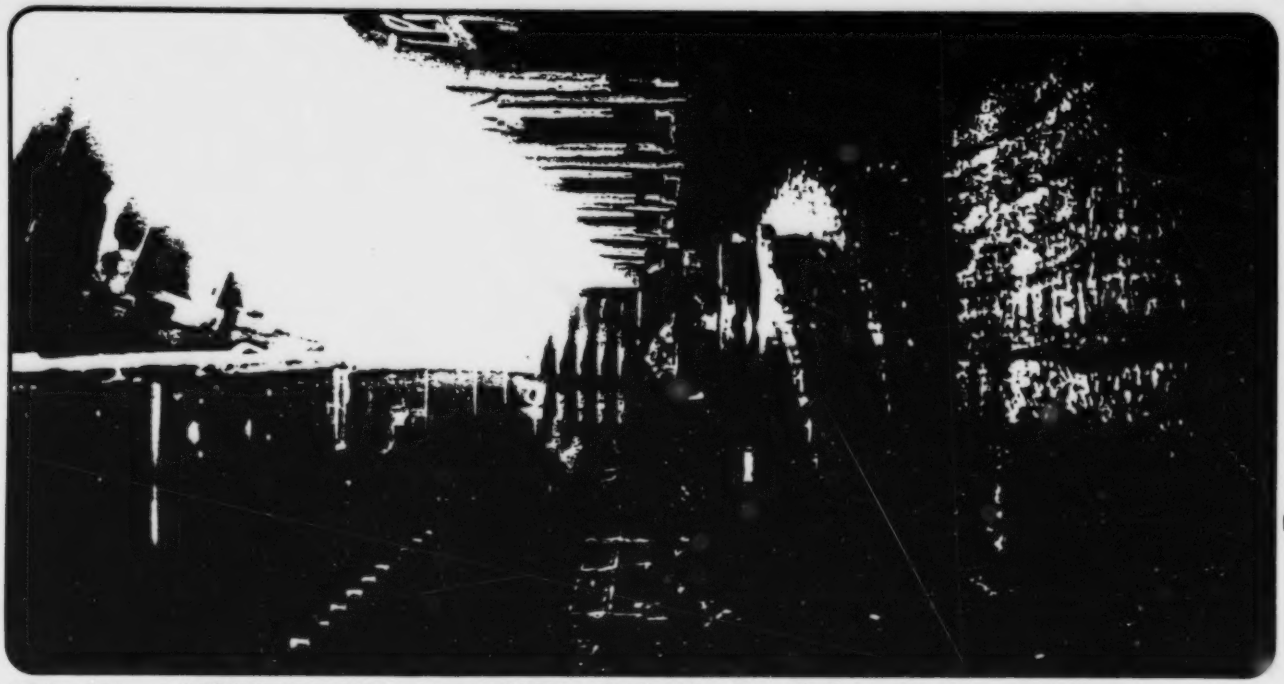
The ranging arm contains the gearing which transmits power from the gearhead gearbox to the cutting drum, and is trunnion mounted in an outboard position on the face side of the gearhead gearbox. The arm is ranged in a vertical plane by means of a hydraulic cylinder located in the shearer underframe and attached to the ranging arm by means of a tapered hub which improves the location and driving action of the drum.

Five lengths of ranging arm are available, as shown in the table, which meet most requirements of seam thickness, stable elimination and roadway profiling. An alternative version of the FH11 arm, FH11D, incorporates a smaller epicyclic gearing assembly which allows a smaller diameter drum to be fitted to suit the thinner seams.

The 2.7m long ranging arm, FH31, incorporates a slow speed epicyclic assembly to reduce the peripheral pick speed of the larger diameter drums.

The total available vertical movement of the arm is 90°, the actual range being determined by the combination of hydraulic cylinder and ranging arm bracket, according to the particular requirements.

FH28	998	+ 765	− 640	+ 640	− 765	1370
FH9	1353	+1035	− 870	− 870	−1035	1370
FH34	1709	+1310	−1100	+1100	−1310	1370
FH11	2064	+1580	−1325	+1325	−1580	1370
FH11D	2064	+1580	−1325	+1325	−1580	1245
FH31	2776	+2125	−1785	+1785	−2125	1650



Another Anderson AM500 shearer working on a longwall face in a South African mine. *(Photo courtesy of Secunda Collieries).*

Cutting drums (Unit 12)

The cutting drums are mounted on the tapered flange of the ranging arm output shaft to ensure maximum grip. The drums are fitted with helical vanes to assist the loading of cut material and dust suppression water is fed, through internal drillings in the drum, to jets on the vane. Details of vane depth and angle, pick type and lacing, are designed to meet particular requirements. The minimum drum diameter is fixed by the diameter of the epicyclic hub.

Dust suppression

A pick face flushing dust suppression system, with water fed through the drum shaft, is provided. This is supplemented by sprays, end mounted on the machine and supplied by the exhaust cooling water from the electric motor and hydraulic haulage system.

Drum ventilation

A hollow shaft venturi system ventilates the face side of the cutting drum to dilute any accumulation of inflammable gas. The air flow is induced by a water jet located at the waste side of the drum shaft.

Lumpbreaker (Unit 11)

A lumpbreaker can be fitted to machines with either chain haulage, or with underframe mounted or intermediate traction units. The lumpbreaker cutting drum consists of a number of cutting discs mounted on a ranging arm driven by the gearhead gearbox through a side gearbox and trunnion box. The ranging arm is raised and lowered by an hydraulic lifting cylinder. This reduces the size of large pieces of material on the face conveyor, and allows easy passage below the shearer.

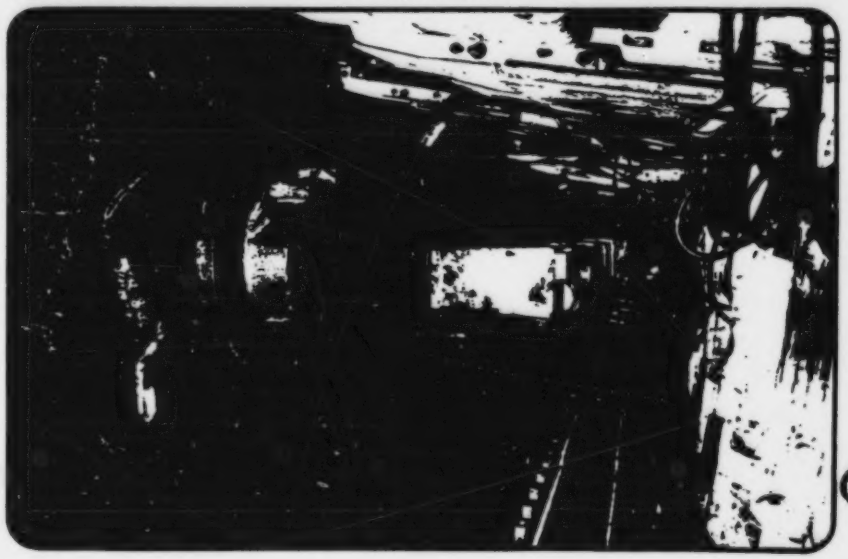
Powered cowls (Unit 13)

The swinging cowl which supplements the loading action of the drum can be rotated through 360° using an hydraulically driven gearing and slewing ring arrangement on the output shaft assembly of the ranging arm.

Underframe (fixed or roll steered) (Unit 14)

This carries the units comprising the machine and gives maximum clearance for the passage of coal. The roll-steered underframe can be hydraulically raised and lowered on the waste side above and below the horizontal. Underframes are available for machines with chain or chainless haulage.

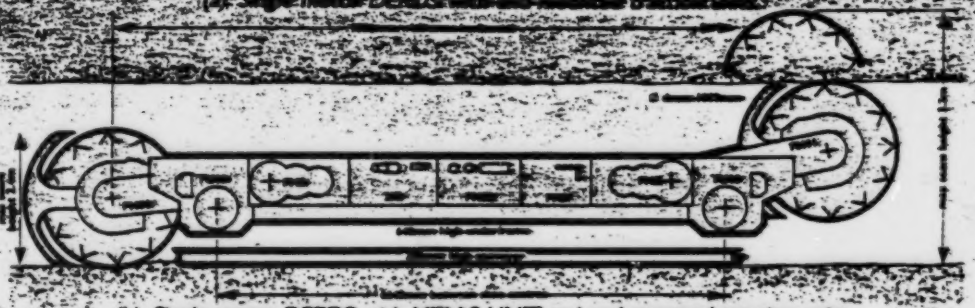
Anderson AM500 at work in a British colliery. *(Photo courtesy of the National Coal Board).*



Typical machine arrangements

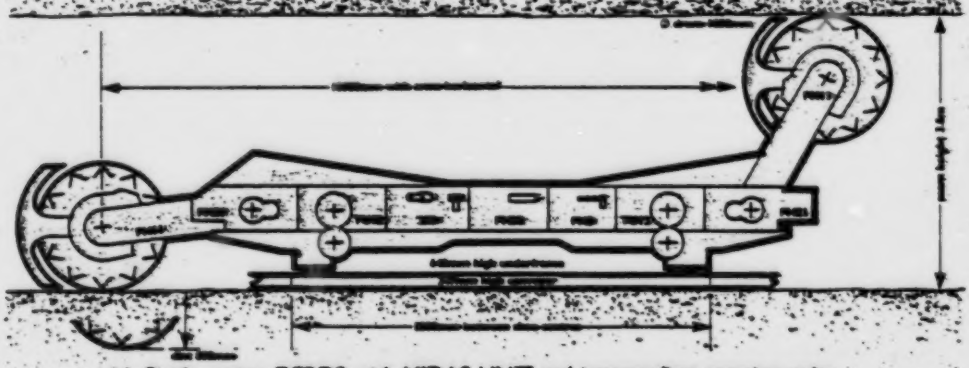
1. Thin-Medium Seams

(a) Single motor DERDS with end-mounted traction units.

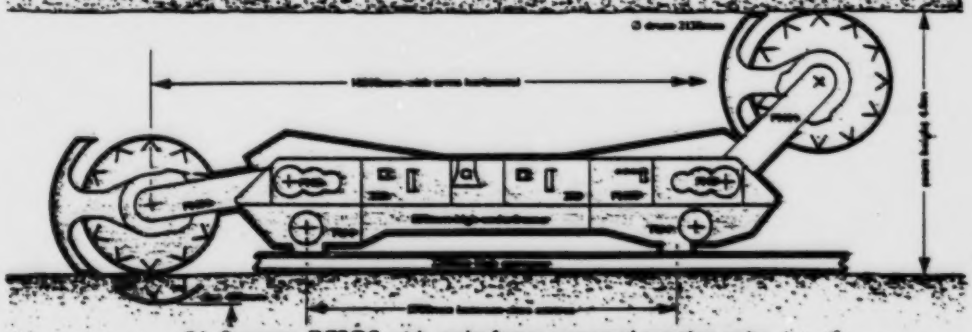


(b) Single motor DERDS with MIDAS UNIT and end-mounted traction units.

2. Medium-Thick Seams

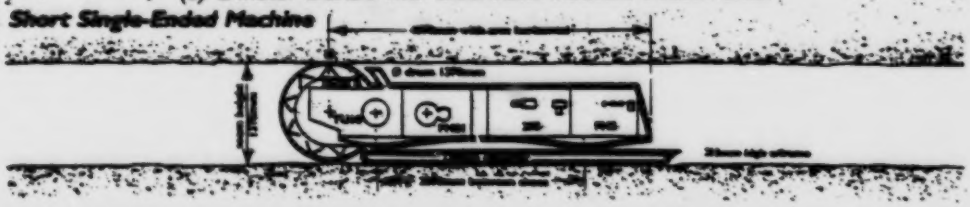


(a) Single motor DERDS with MIDAS UNIT and intermediate traction units.



(b) 2-motor DERDS with underframe-mounted traction units.

3. Short Single-Ended Machine



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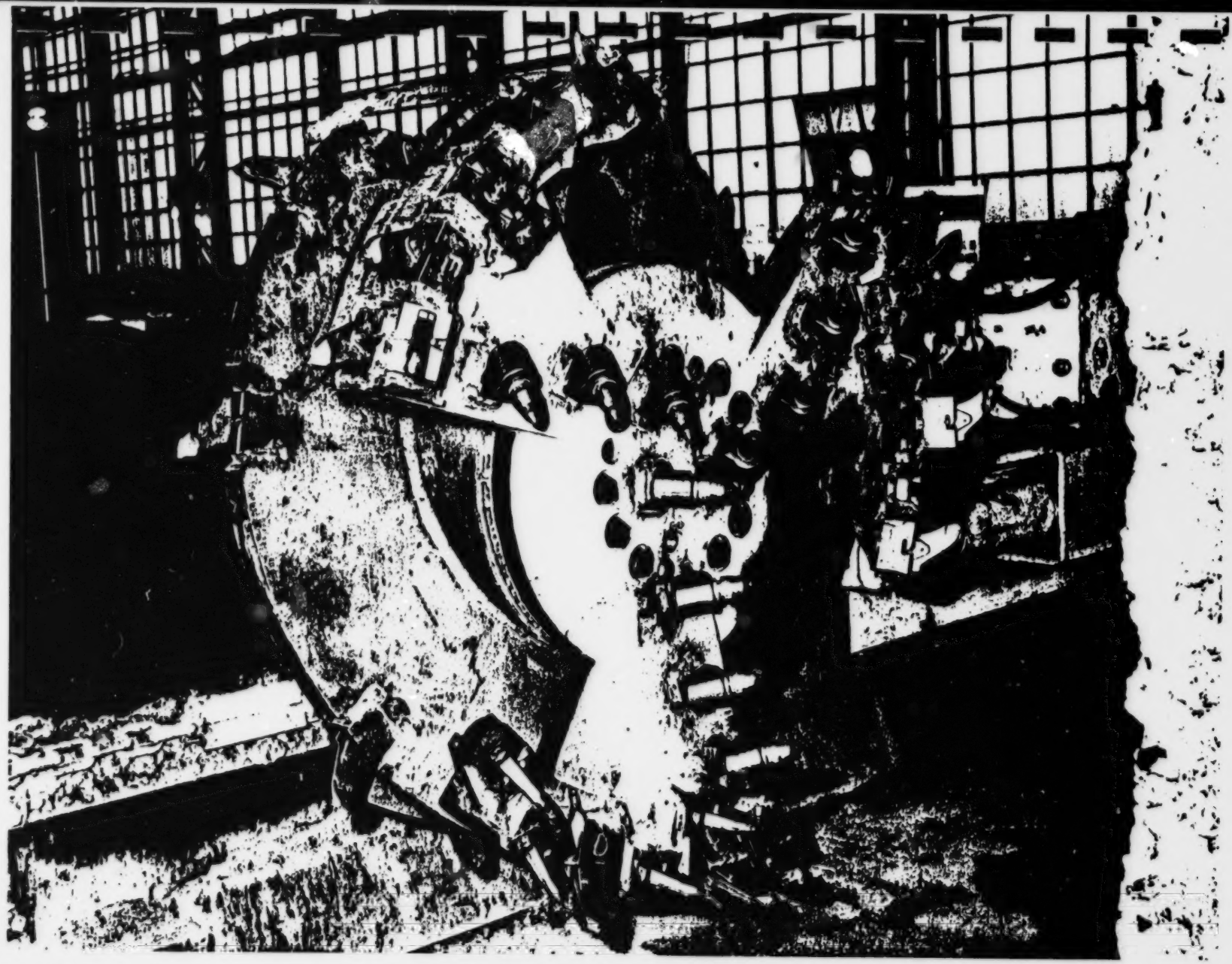
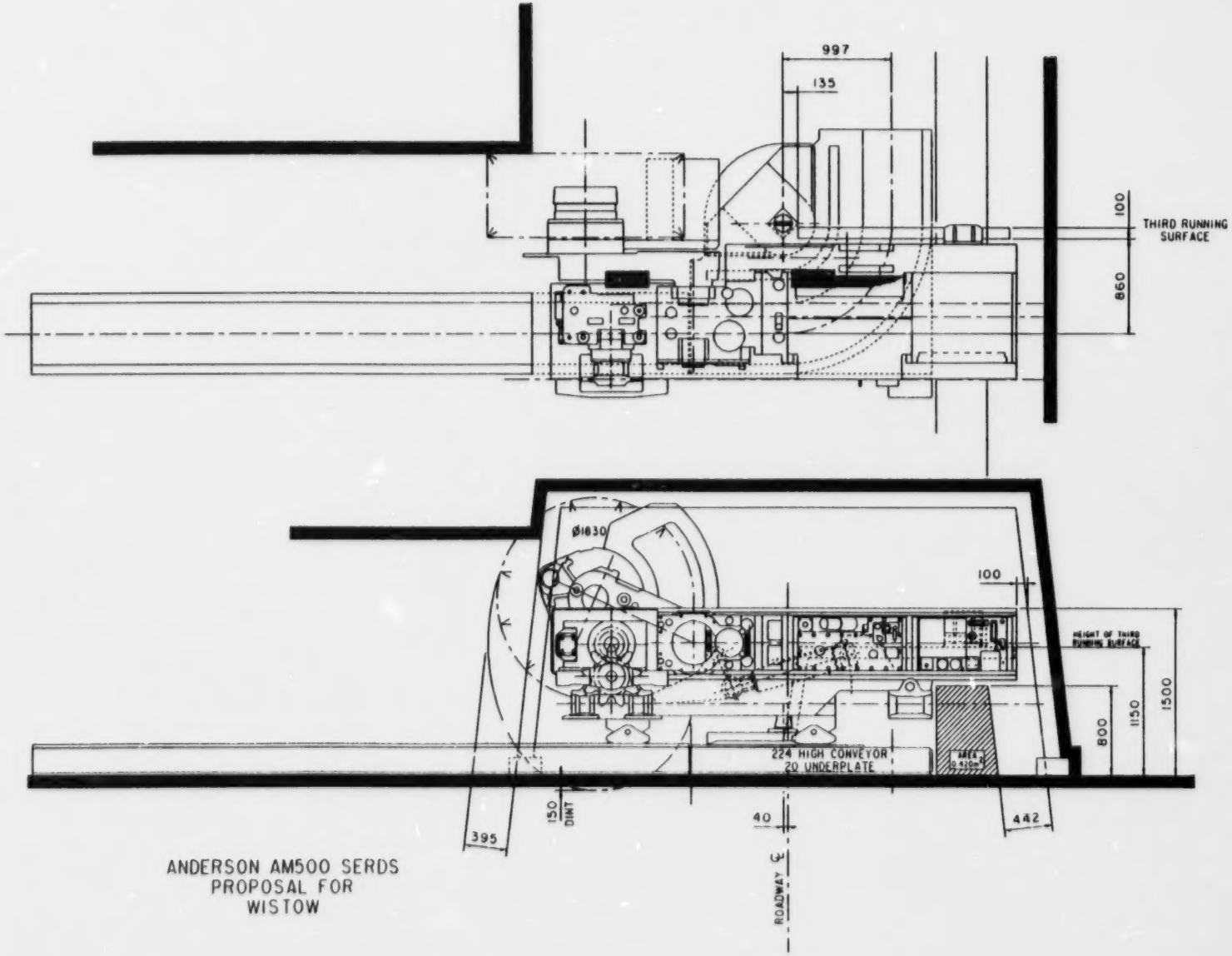
GENERAL SPECIFICATION

SHORT AM500

MOTOR	400 HP, 500 HP OR 600 HP AT 1000V - 4160V
HAULAGE	SINGLE TRACTION UNIT - 30 TONS DOUBLE TRACTION UNIT - 60 TONS MAX CUTTING SPEED - 12 M/MIN
DRUM REVS	29.3, 37.3 AND 46.6 RPM
RANGING ARMS	1.0 M OR 1.3 M OR 1.7 M LONG
SEAM RANGE	1.4/3.5 M APPROX.



SUMPING DRUM DEVELOPED BY ANDERSON STRATHCLYDE
FOR USE ON SHORTWALL AND SINGLE ENTRY FACES



ANDERSON AM500 SERDS
PROPOSAL FOR
WISTOW

Anderson Strathclyde PLC

LOCATION	
MOTHERWELL	
BRIDGETON	
KIRKINTILLOCH	
SAUNDERTON	

CAD

DRAWN BY A. TILLEY

APPROVED BY

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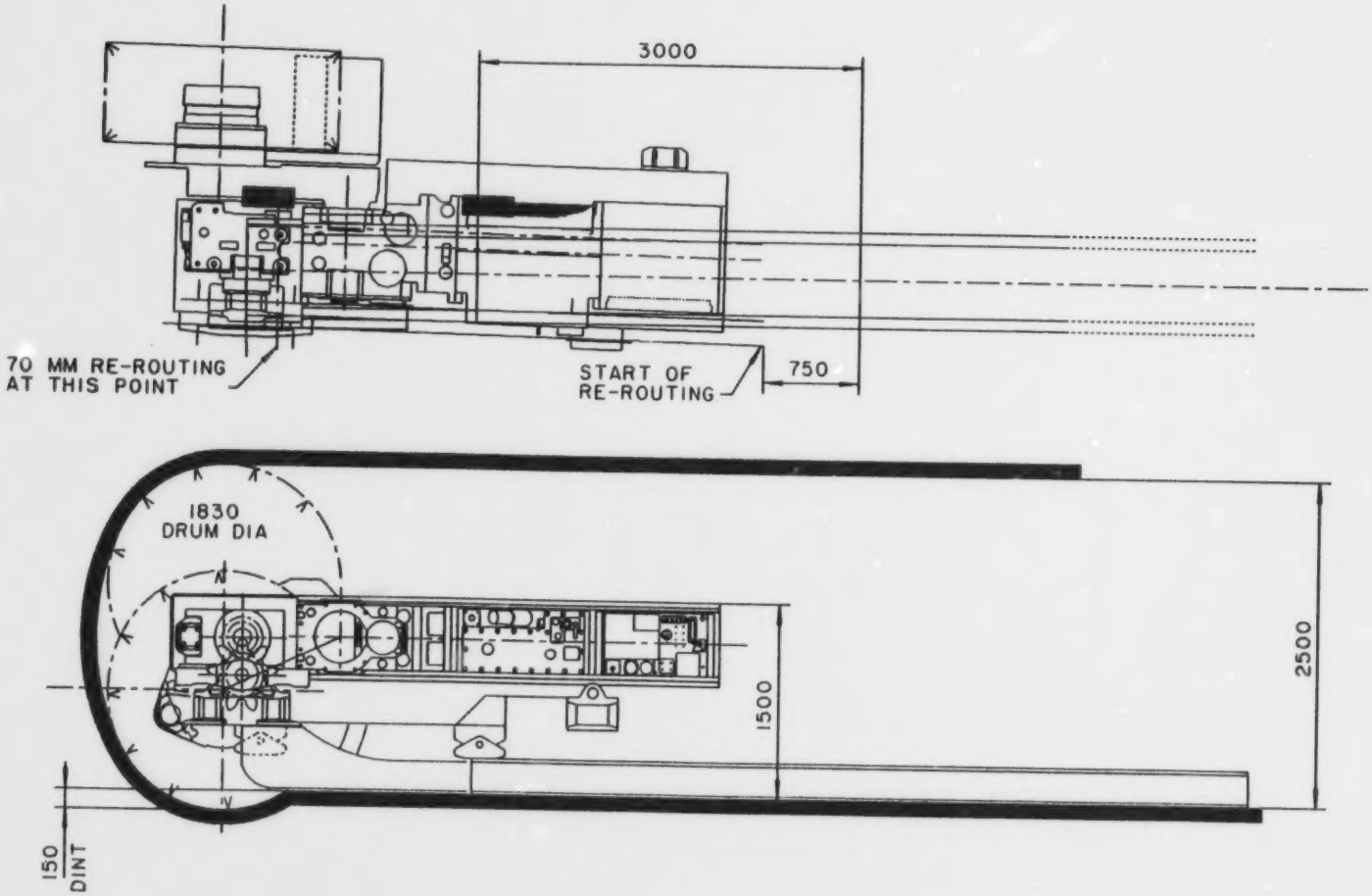
ISSUE No	DSC No	Date & Sig	PHOTO

REF RDS500.1392.001



TAILGATE CUTPAST OF
ANDERSON AM500 SERDS
FOR WISTOW

Anderson Strathclyde PLC

LOCATION	
MOTHERWELL	
BRIDGETON	
KIRKINTILLOCH	
SAUNDERTON	

CAD

DRAWN BY A. TILLEY

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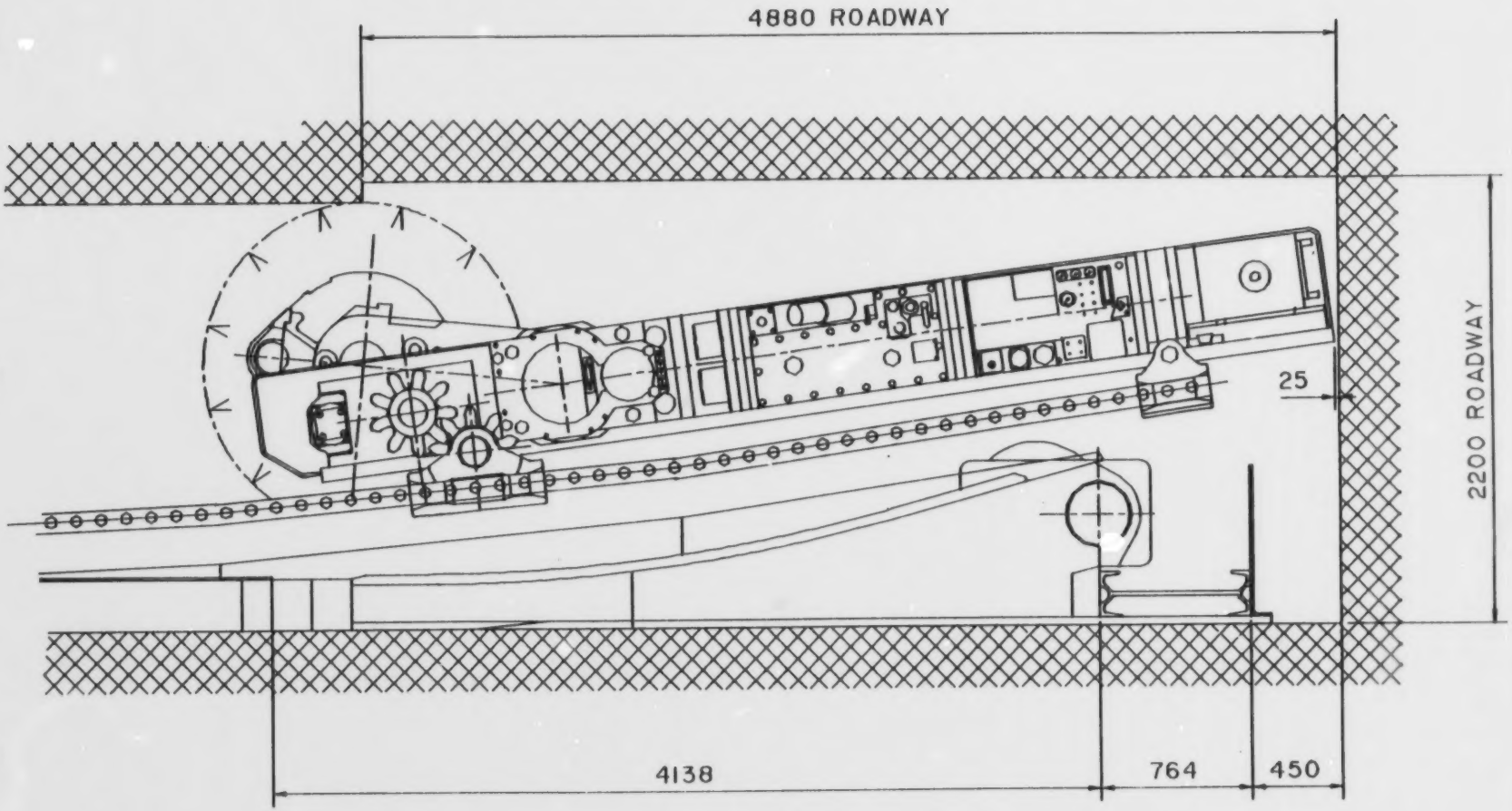

ANDERSON AM500 SERDS
MAINGATE CUT-PAST
GRETLEY - AUSTRALIA
ON DOWTY CONVEYOR

Anderson Strathclyde plc

LOCATION
MOTHERWELL
BRIDGETON
KIRKINTILLOCH
BAUNDERTON

CAD

DRAWN BY T. ROBERTSON

APPROVED BY

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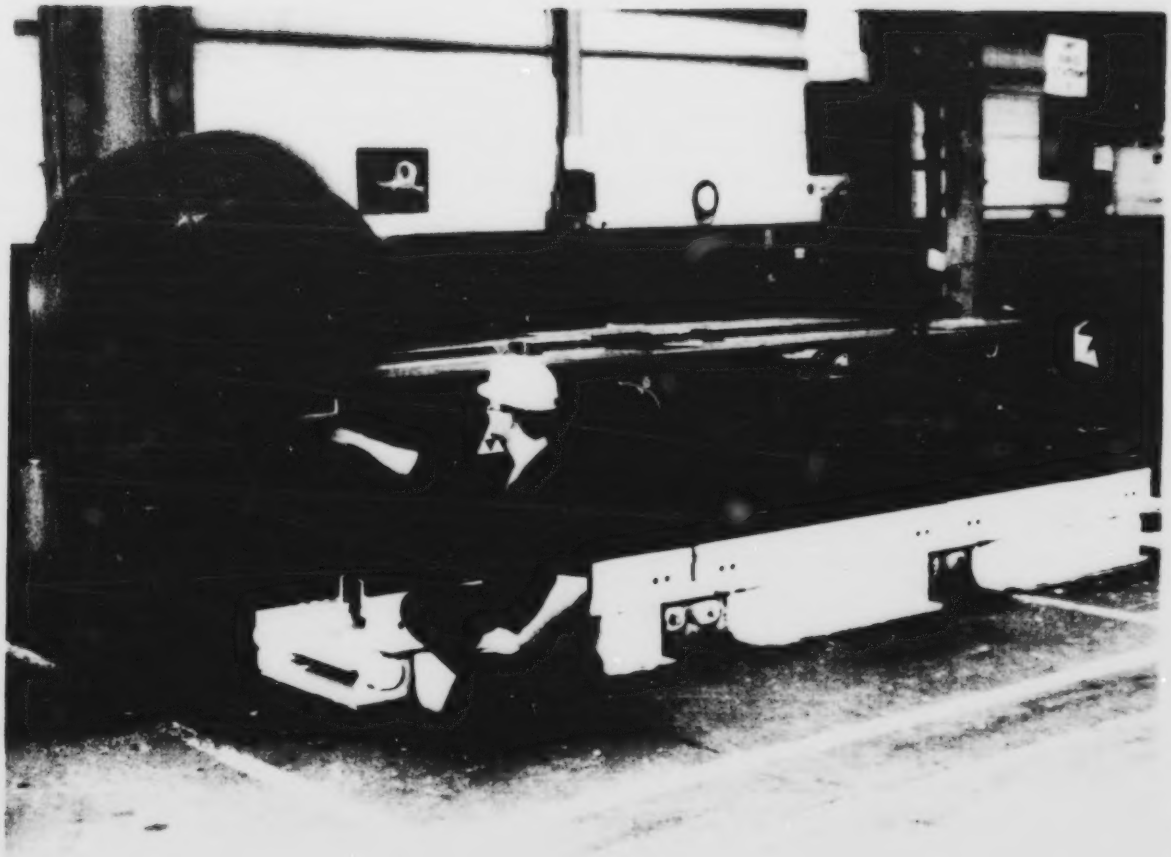
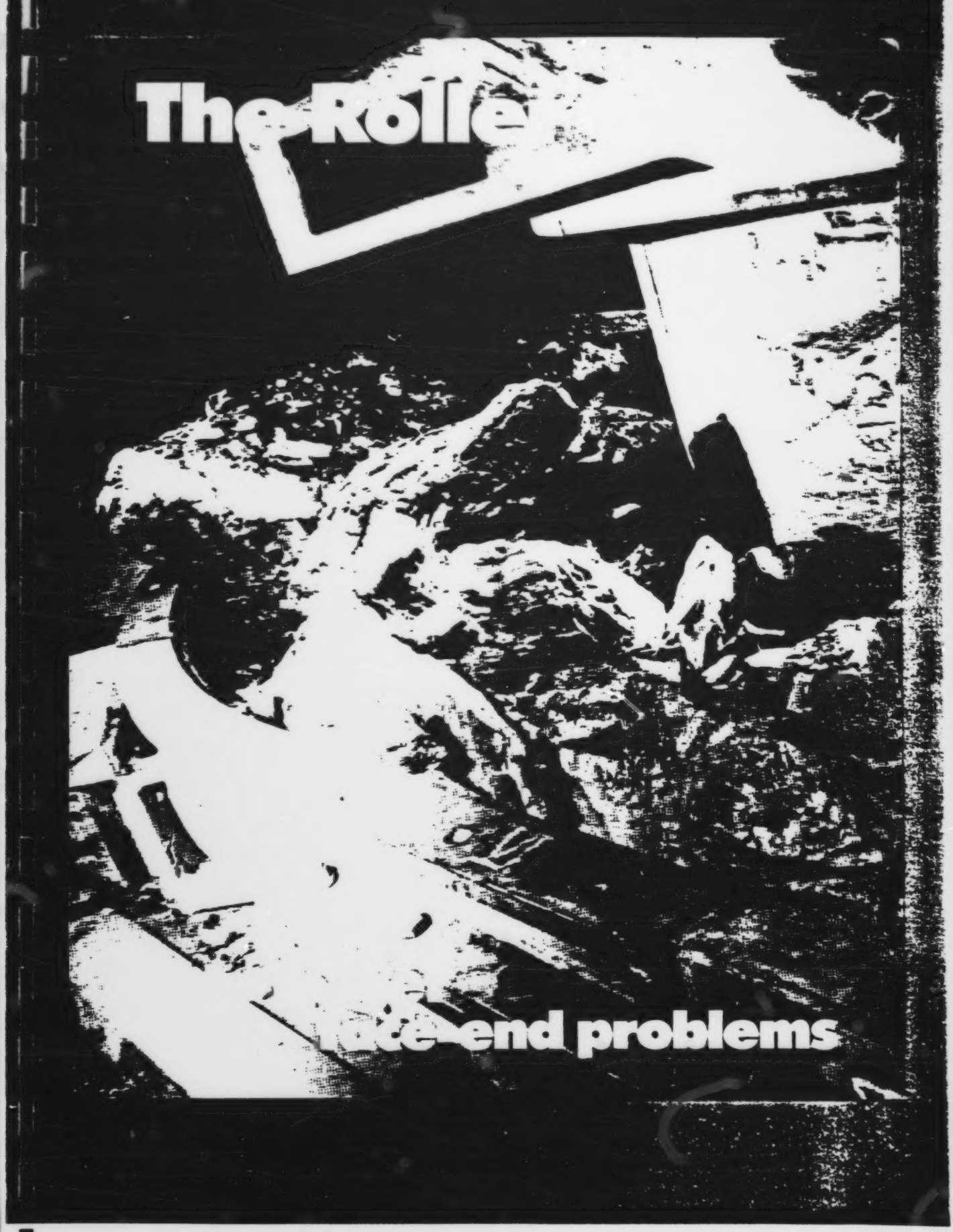
RDS 500.1135.004



ANDERSON STRATHCLYDE AM 500

SHORT SINGLE ENDED RANGING DRUM SHEARER

FOR SINGLE ENTRY AND SHORTWALL WORKINGS

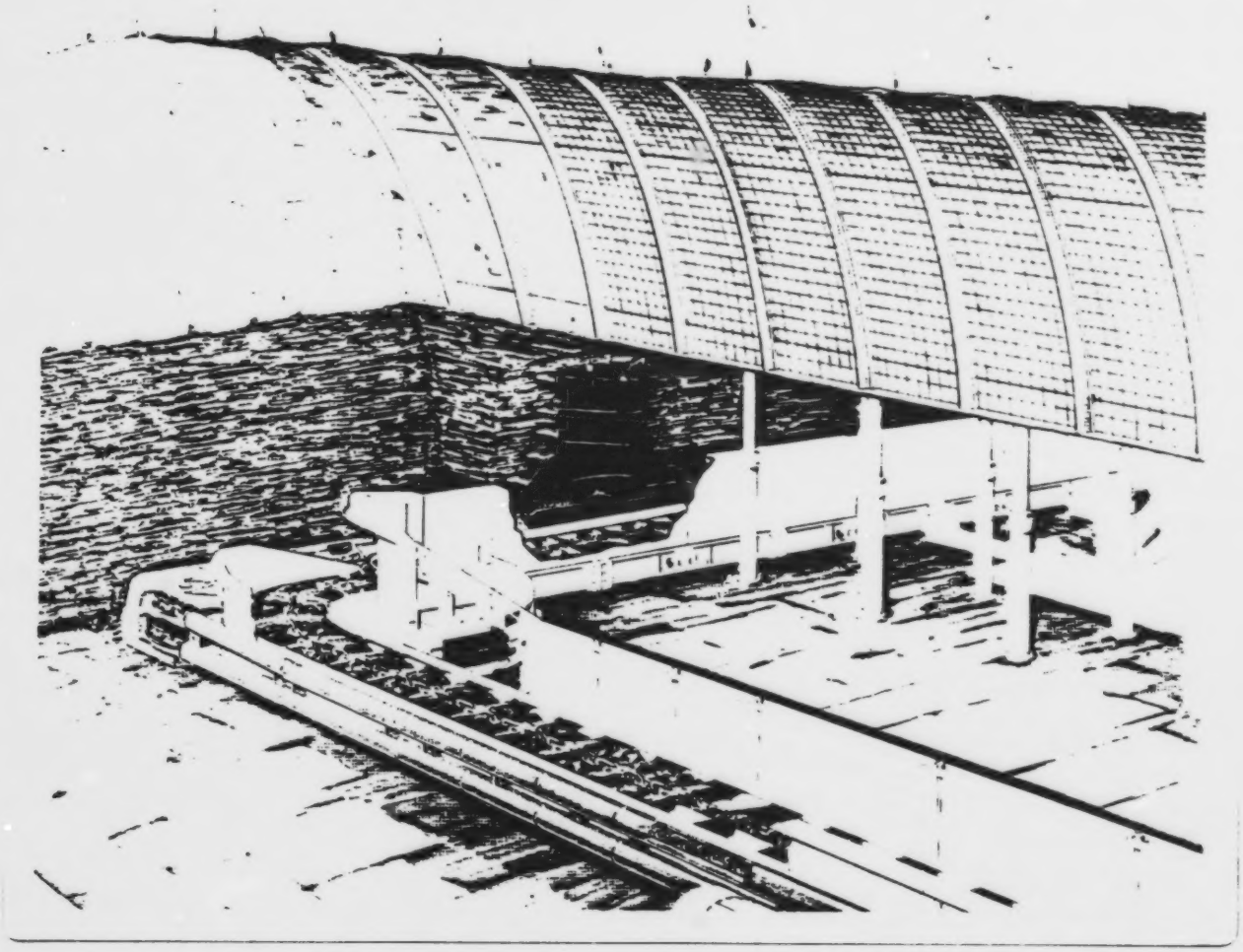


HALBACH & BRAUN

The most problematic areas in longwall mining are face ends or T-junctions. Here at the most critical point a lot of work has to be done like road-heading, supporting, anchoring. The big drive and motor units of the face conveyor and the delivery from face conveyor to stage loader need a lot of the space. The delivery causes dust where most of the miners have to work. These problems are eliminated by means of the Halbach & Braun roller curve, which proved its advantages in many applications within the last years.

- Face conveyor and stage loader become one unit
- All drives are remote at the end of the stage loader
- No dust at the T-junction as coal is transported smoothly and on one level round the corner
- Shearer loader can move over the roller curve to cut the roadway

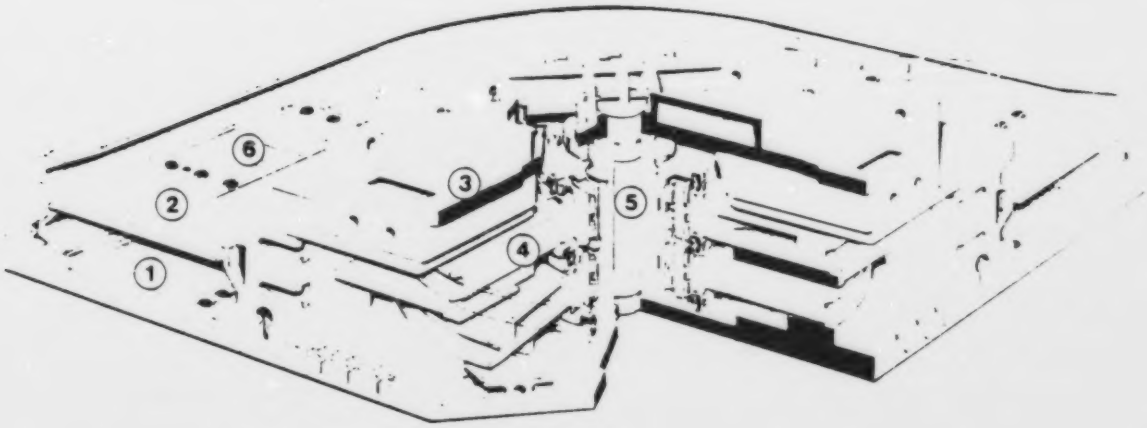
The roller curve makes the face end safer in a comfortable and economic manner.



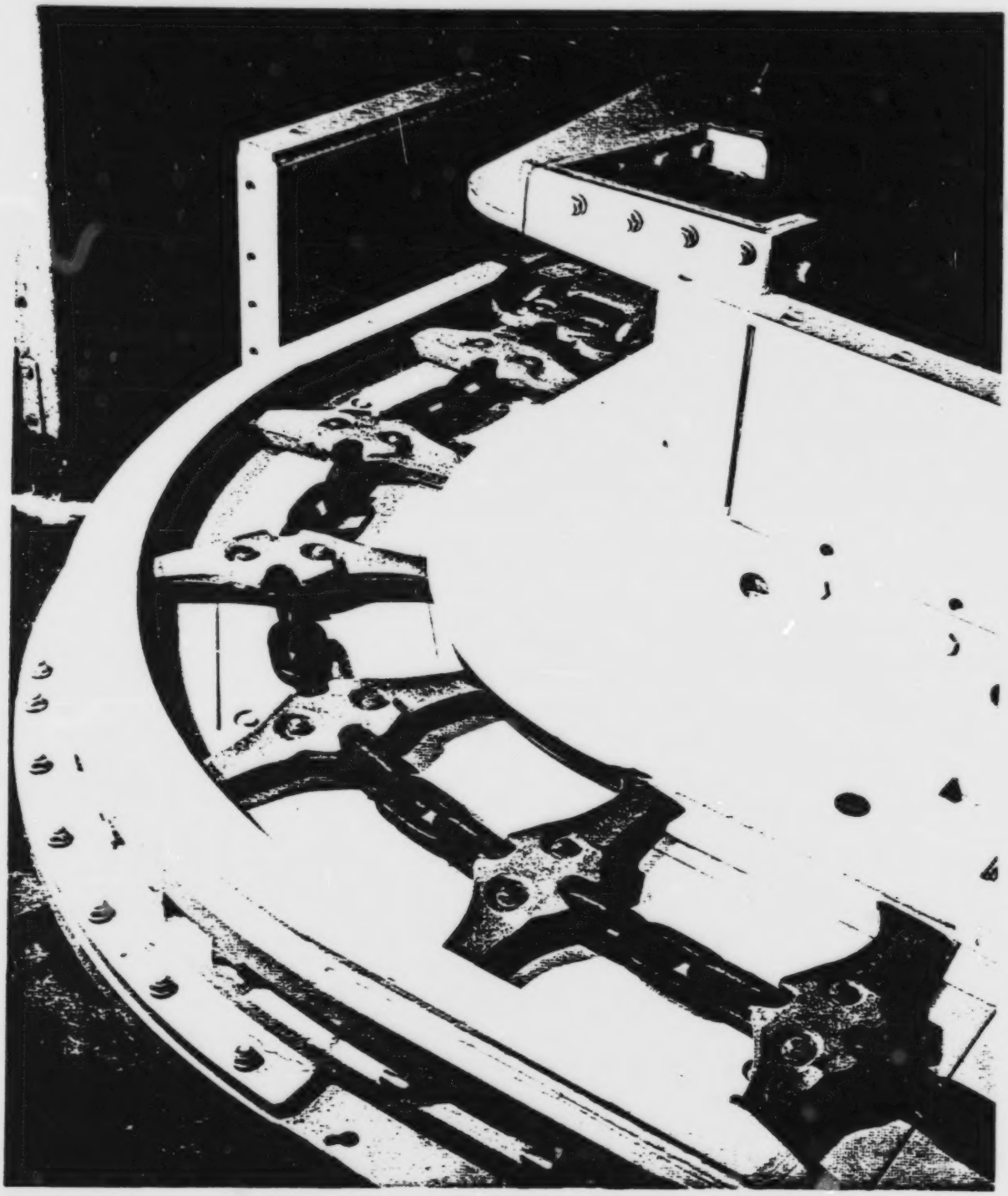
HALBACH & BRAUN

The heart of the roller curve precise and robust

① outer floor plate
② profile frame with window
③ roller curve box RK 90 ZLV
④ roll set with bearing
⑤ Assembling axle
⑥ Filling box



Roller Curve 3 RK 90 ZLV with chain strand EKF 3 - 34 x 126, flight distance 4 links



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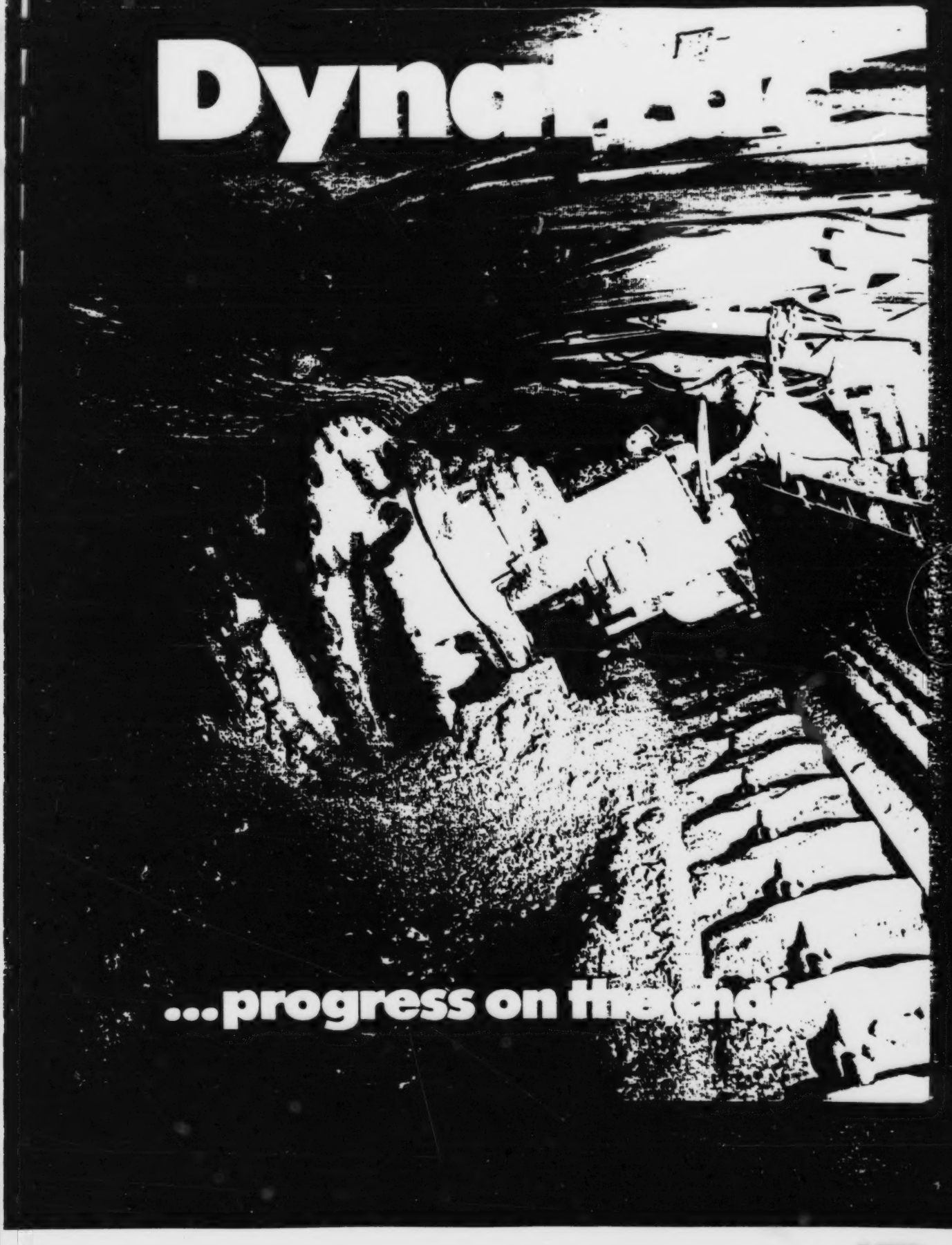
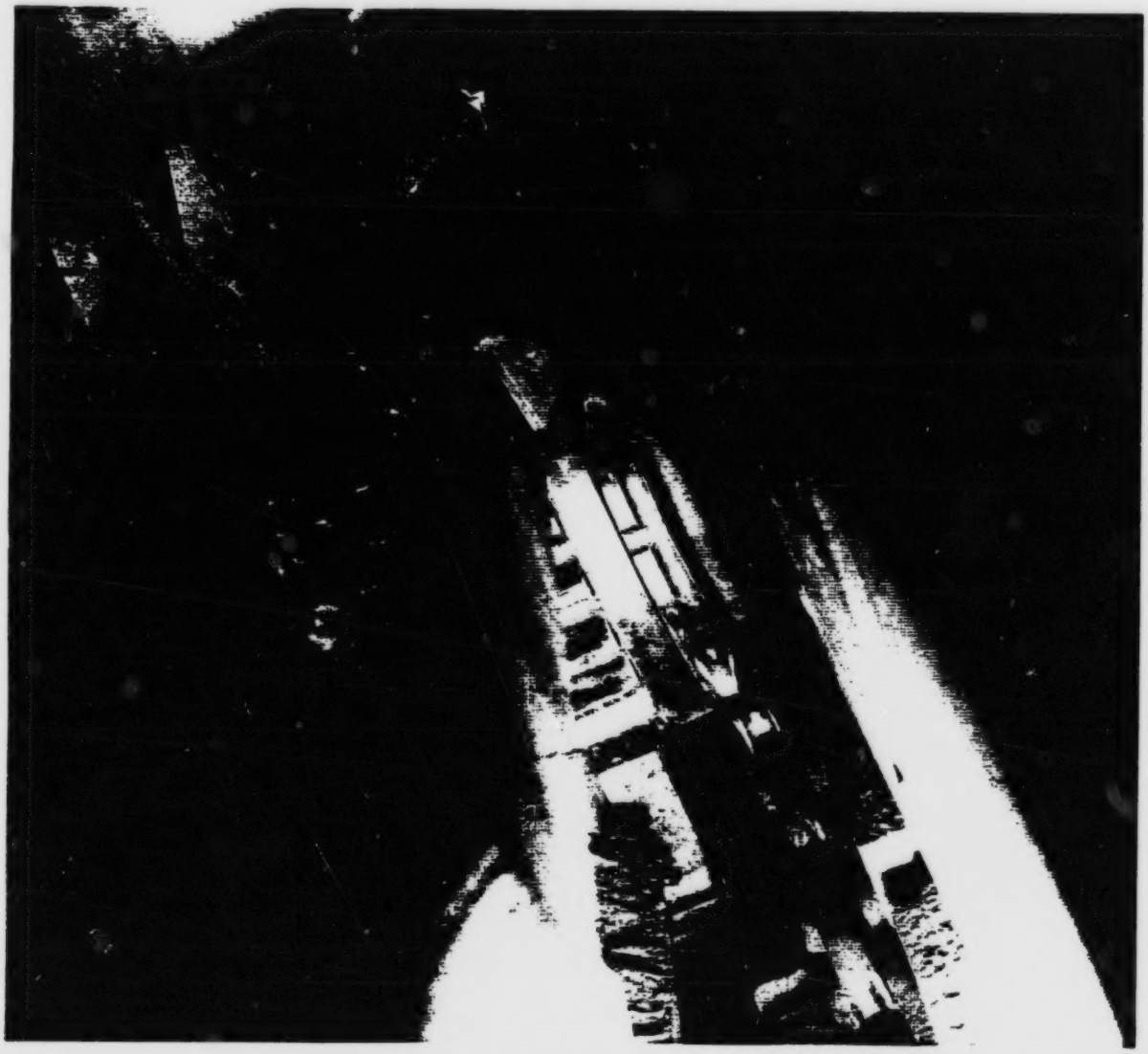


HALBACH & BRAUN

DYNATRAC is the dynamic haulage system for drum shearers, developed by Halbach & Braun. It consists of a specially designed link chain captivated either at the gob- or face side. The chain guide also serves as a support for the drive sprocket of the drum shearer.

The drive mechanism of the haulage unit transmits power to a gear unit, thus hauling the drum shearer along the face. Dynatrac is universal, it can be adapted to every existing shearer executed and fits to every existing kind of chain conveyor.



HALBACH & BRAUN

There are the advantages:

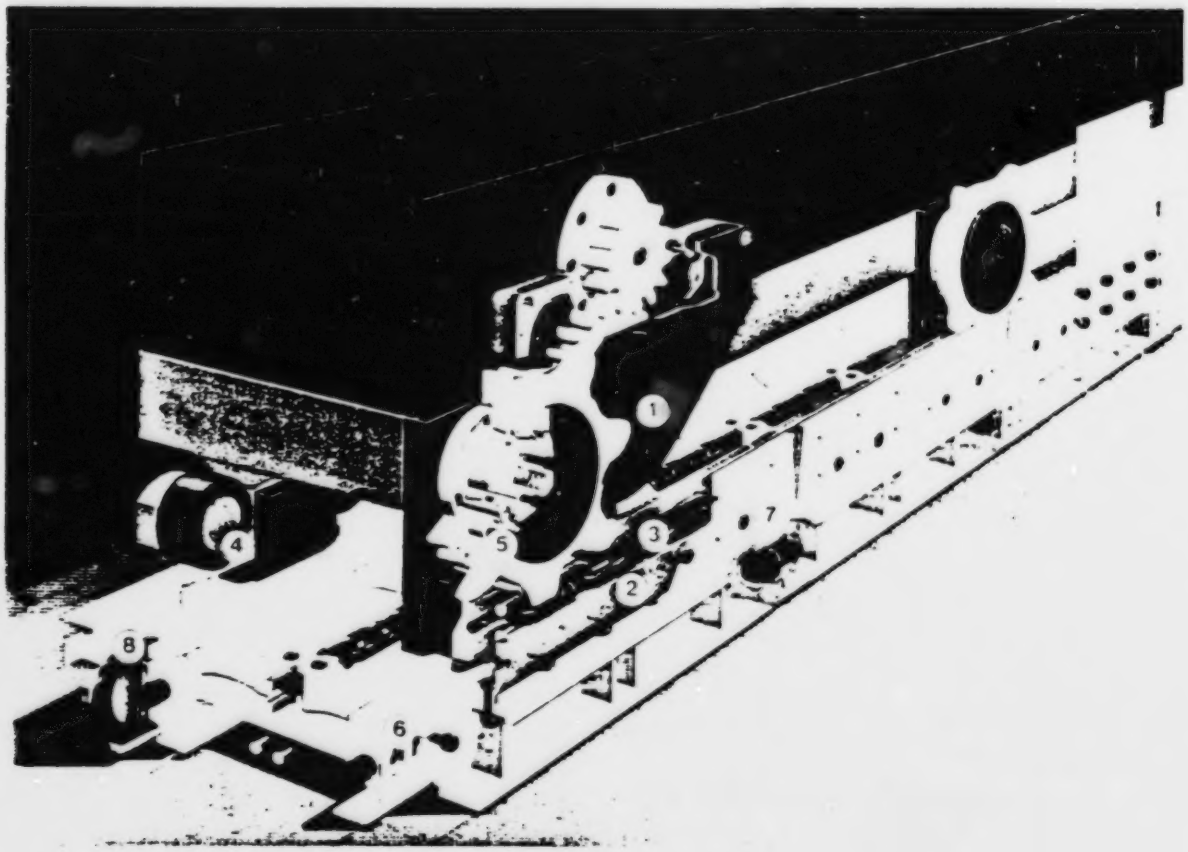
The principle dynamic behaviour of the link chain

- The flexibility of the chain prevents the extremely high blocking effect, that occurs when the drum shearer is broken into coal. Consequently, protecting the drive system and the gear transmission of the shearer.
- The flexibility of the chain makes it possible to push the conveyor towards the face immediately behind the drum shearer.

Some of the other advantages in detail

- The exact pitch of the chain, even though the conveyor has been pushed over to the face and the line pans are lying at an extreme angle, guarantees an uninterrupted performance of the drive sprocket.
- The short vertical chain link prevents emboxing of the special chain.
- No delay when advancing the roof support. The conveyor can be pushed towards the face right behind the shearer with excellent movement provided for line pan. Vertical 6 degrees, horizontal 1.5 degrees. The pitch of the chain is independent from the conveyor.
- Relative motion when pushing conveyor towards the face.
- The relative narrow DYNATRAC chain guide guarantees a large cross section, thus providing good performance of the conveying system.
- The DYNATRAC chain can be used twice by simply turning the chain 180 degrees.
- Adaption of the shearer to DYNATRAC for various seam heights is easily possible.
- Rolling friction at all 4 supporting points provide better performance and utilization of the haulage system. Consequently a booster haulage is not necessary.
- The easy to exchange captivation at the axle center line of the shearer guarantees that the shearer will pass through rolls and dips of the longwall face in a secure and safe manner.
- DYNATRAC is economical and affordable.

DYNATRAC as a system in combination with other compatible and well approved Halbach & Braun products:



Drive set – available for all drum shearers
DYNATRAC chain guide with support bar designed as one unit
Special DYNATRAC chain – cannot be pushed together
Runner
Drive sprocket and runner are one unit
Conveyor with 3D connector – 85 tons
Base frame with 3D connector – 300 tons
Runner bar with strap joints – 120 tons

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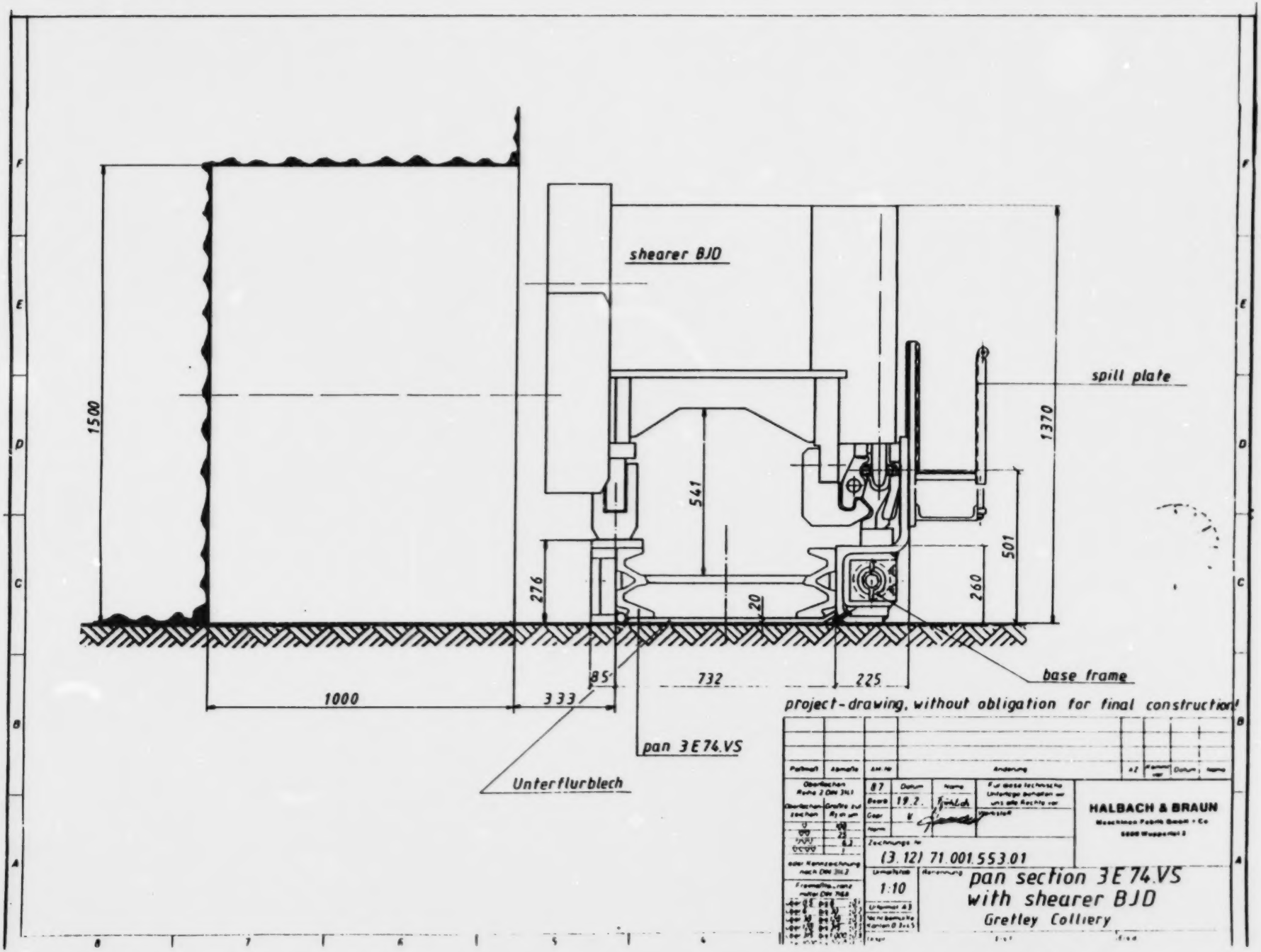
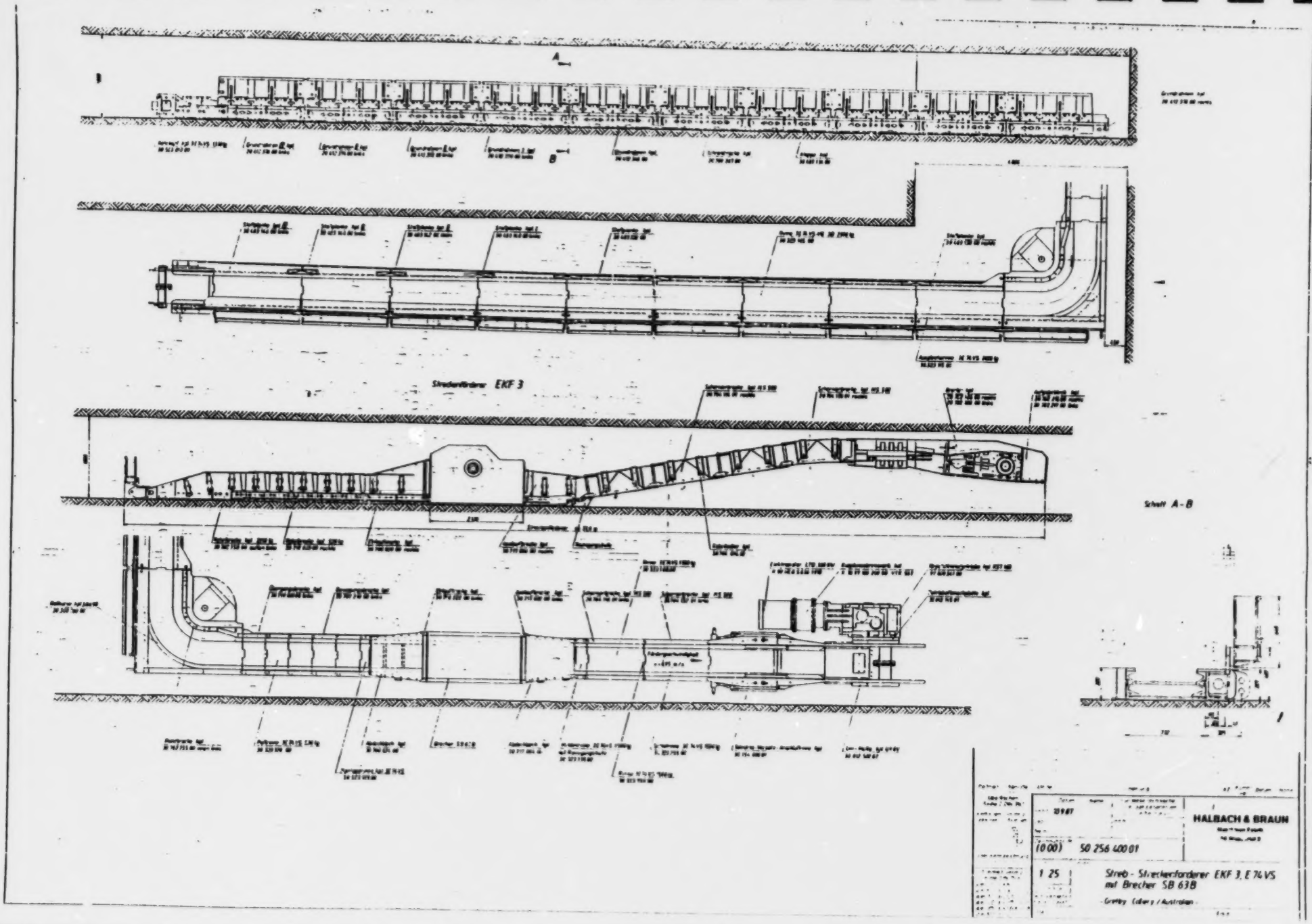
90 W. Chestnut Street · Millcraft Center
Washington, PA 15301 · USA · ☎ 412-225-7840 · Tx 510-6908592


shearer BJD
spill plate
1500
1370
541
501
276
260
20
85
732
225
1000
333
base frame
pan 3E74.VS
Unterflurblech
project-drawing, without obligation for final construction!
87
19.2.
HALBACH & BRAUN
(3.12) 71.001.553.01
1:10
pan section 3E74.VS
with shearer BJD
Gretley Colliery



Streckenförderer EKF 3
Schnitt A-B
HALBACH & BRAUN
(0 00) 50 256 400 01
1 25
Streb - Streckenförderer EKF 3, E 74 VS
mit Brecher SB 63B
Gretley Colliery / Australien

face conveyor EKF 3

tail gate

main gate

retreating system

stage loader EKF 3

pan section face conveyor

scale 1:10

section C-D

section A-B

scale 1:10

project - drawing, without obligation for final construction !

HALBACH & BRAUN

(014) 71 001 554 00

125

face conveyor and stage loader EKF 3
with BJD shearer

Greiley Colliery / Australia

WULTEX

MACHINE COMPANY LIMITED

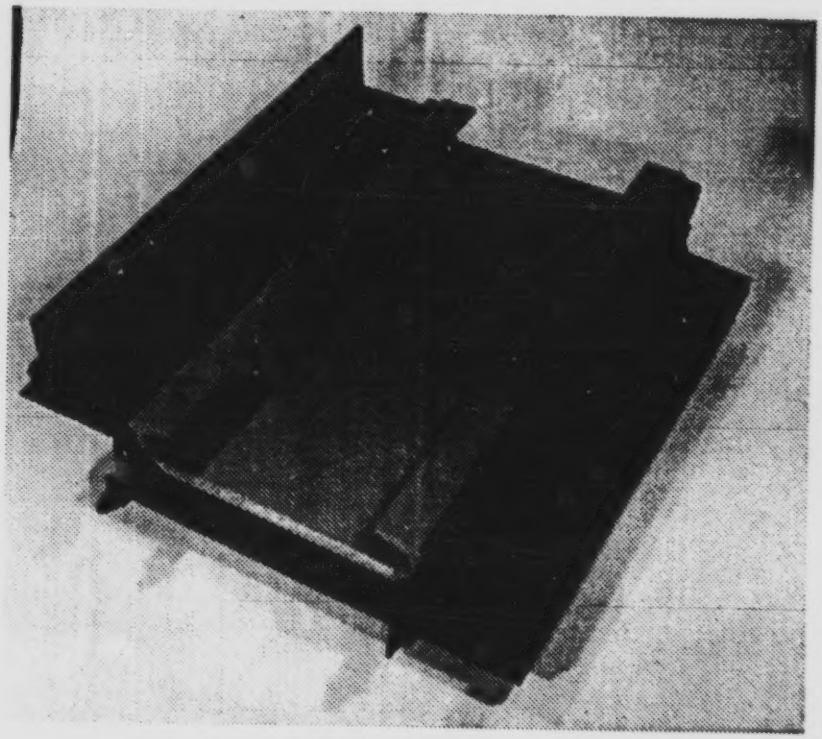
THE WULTEX - BECORIT CURVED ARMOURED FACE CONVEYOR

WULTEX

The Wultex - Becorit Armoured Face Conveyor

Detachable Top Pan

Pans used with the curved A.F.C. can be the Detachable Top Deck type (as shown), Split Profile type, both allowing a deck plate thickness of choice, or a standard 268 mm type.



Harness Chain

Chains used can be of the Single Centre Strand type or alternatively the Harness type. The Harness type is a double centre strand chain with five links each of 30 mm between the scrapers. The chains are load compensated by the scrapers which have a central link welded on from which compensation yokes are permanently connected by welded tooth bridges. The end links of the chain are held in position on the compensation yoke by a strong stud. The scraper central link and slewing compensation yokes have a breaking strength 25% above that of the two chains together.

Harness Chain Drive Sprocket

The Harness Chain is driven via a three toothed haulage rack wheel of 741 mm diameter, whereby the power is transmitted not to the chains but to the harness scrapers. The haulage rack teeth grip between the chains and press over a wide area against the toothed bridge of the compensation yoke. The flat chain links press against polygon rings on the drive drum.

Curved Section with Harness Chain

Two types of curve are in use, the Disc Curve and the Roller Curve.

The Disc Curve is basically a box that houses two contra rotating discs of 1.4m or 1.7 m diameter. The discs function is to support the scrapers on the inner radius of the curved pan line. Three scrapers lie on the curve area.

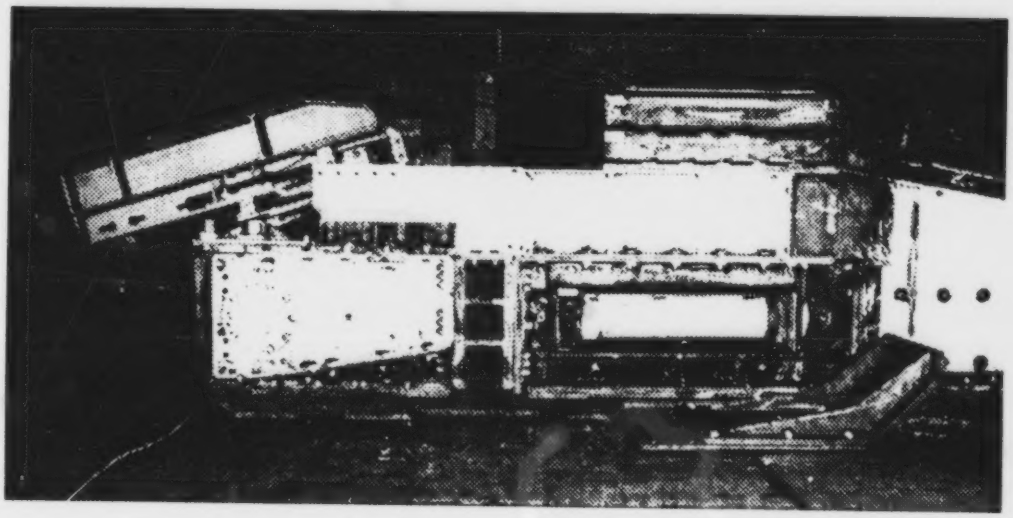
The Roller Curve corresponds to a curved pan train of inner radius 2.35m. Support rollers on the curved section can be replaced as assemblies for the upper and lower strands. The rollers are lubricated for life. Six scrapers lie on the curve area and for transport purposes the 90 degree curve can be split into three sections.

WULTEX

The Wultex - Becorit Armoured Face Conveyor

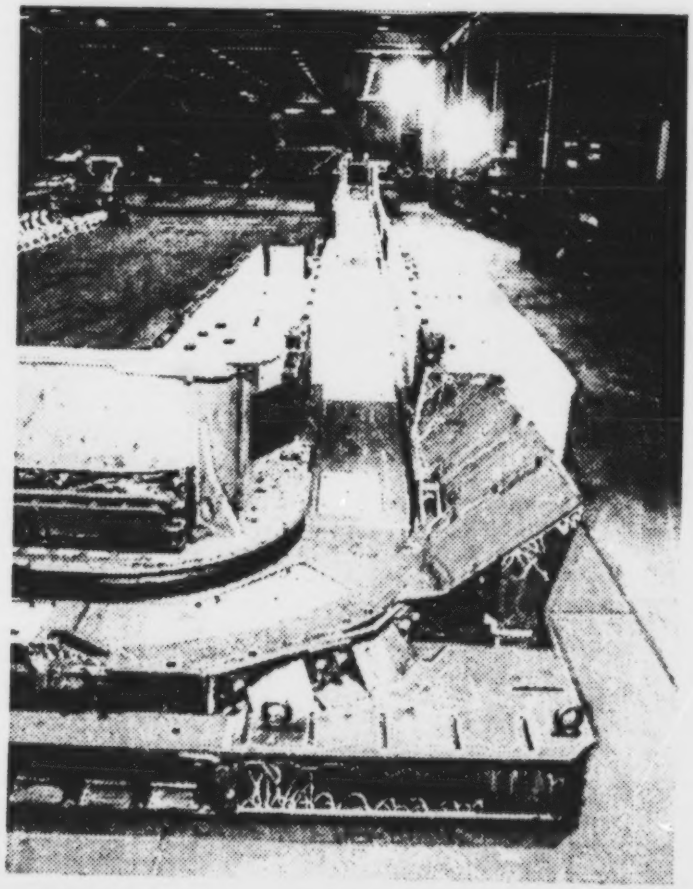
Tension Pan

The Tension Pan fits immediately behind the drive unit and consists of a sliding pan arrangement powered by a single heavy duty ram. The arrangement is essential when using the harness chain.



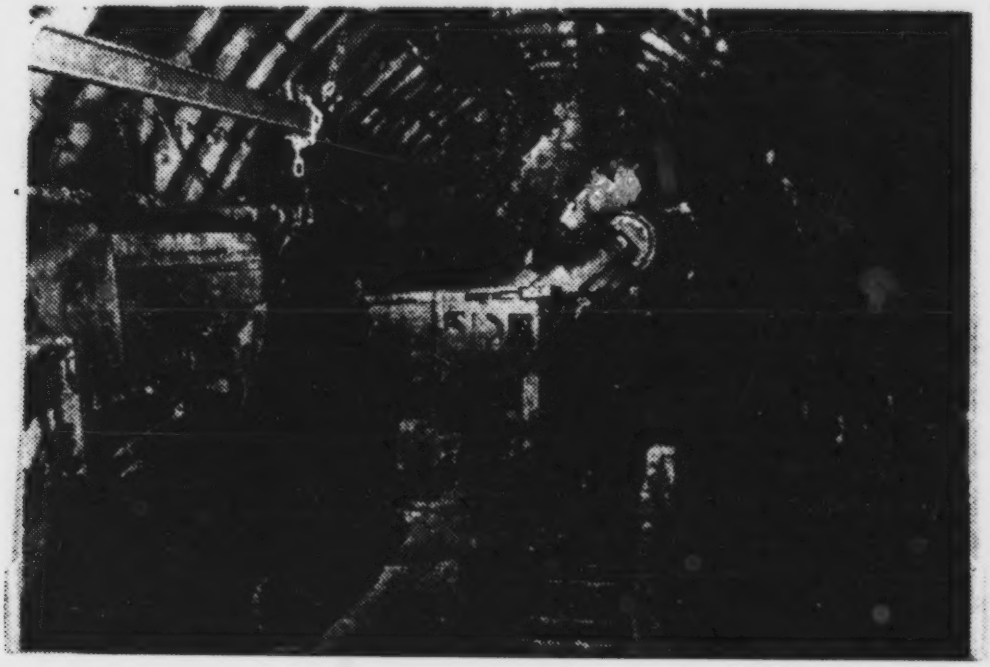
Roadway Section of Curved Conveyor

The stage loader section can be clearly seen from this factory photograph. Behind the curve can be seen an optional platform on which would stand a ripping machine.



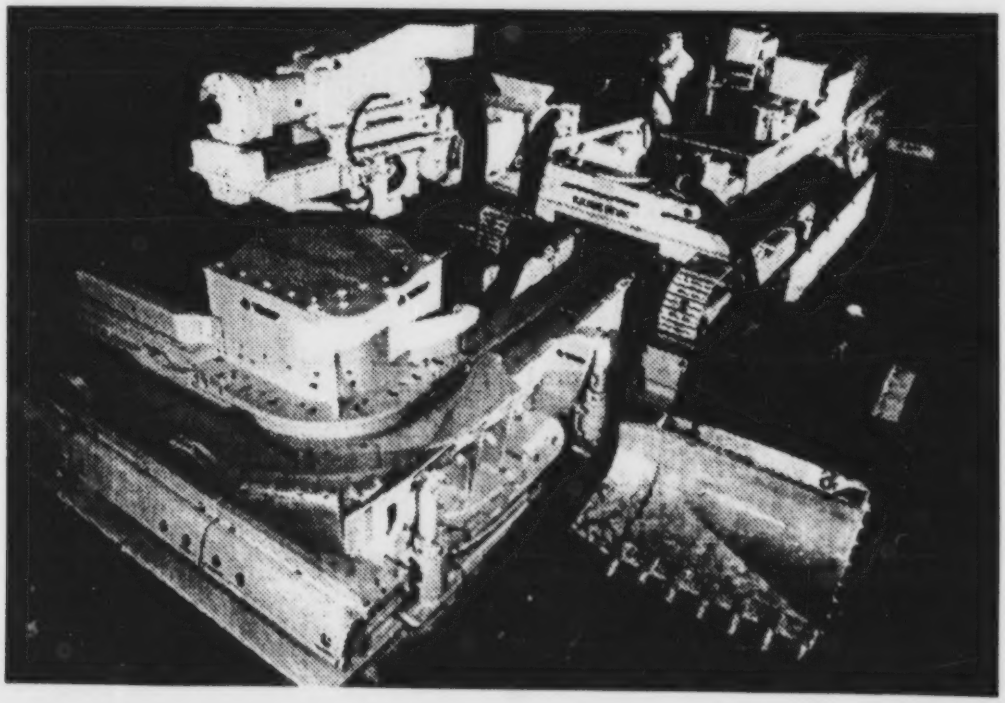
Face End Underground

The photograph shows a Curved Conveyor at a loader gate end with a D.E.R.D.S. cutting across the road head and the hammer head of an Impact Ripper that is sitting astride the stage loader section.

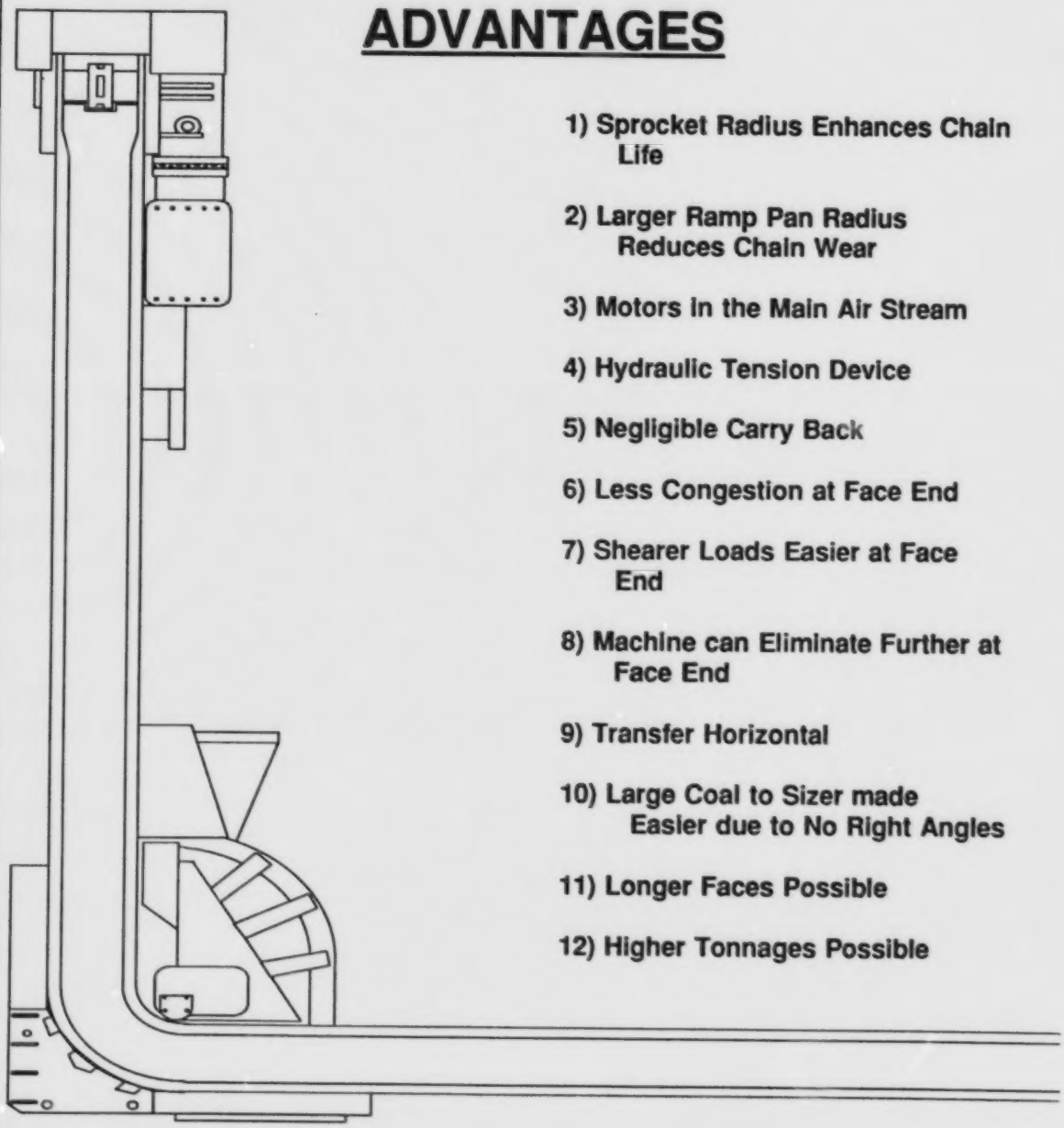


Impactor & Bucket Loader in Factory

The photograph shows a curved section of the A.F.C. with an Impact Machine astride the stage loader section and a Bucket Loading Machine for extraneous debris that does not fall on to the face conveyor.



The Wultex - Becorit Curved Armoured Face Conveyor



ADVANTAGES

1) Sprocket Radius Enhances Chain Life
2) Larger Ramp Pan Radius Reduces Chain Wear
3) Motors in the Main Air Stream
4) Hydraulic Tension Device
5) Negligible Carry Back
6) Less Congestion at Face End
7) Shearer Loads Easier at Face End
8) Machine can Eliminate Further at Face End
9) Transfer Horizontal
10) Large Coal to Sizer made Easier due to No Right Angles
11) Longer Faces Possible
12) Higher Tonnages Possible

Wultex Machine Co. Ltd.

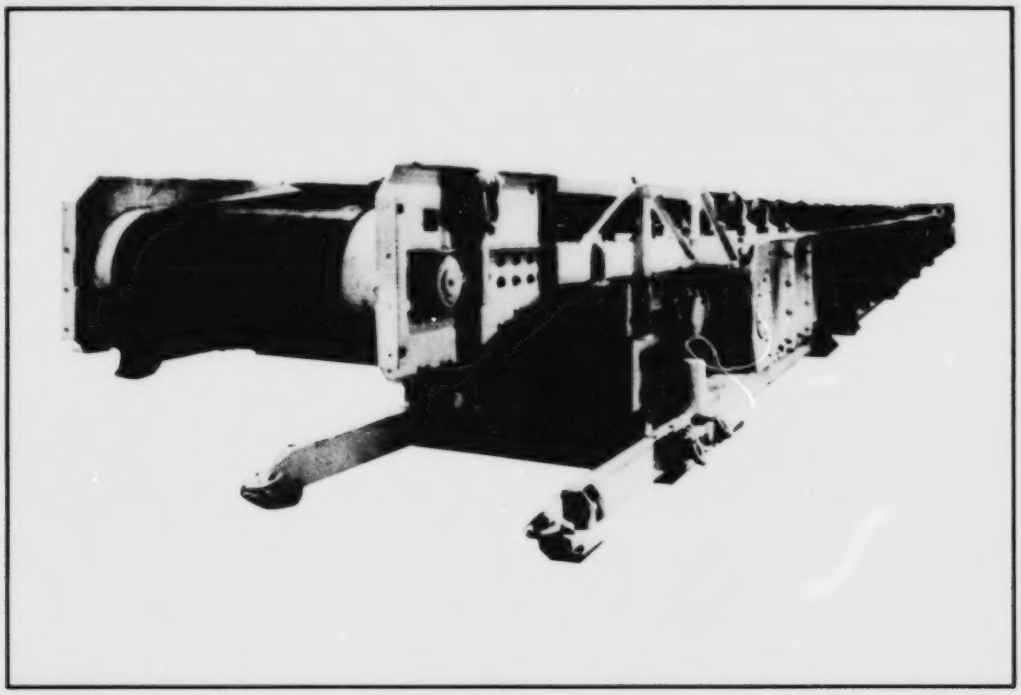
PROGRESS WORKS
Ivy Street East, Aspley
Huddersfield. HD5 9AF
TELEPHONE : (0484) 546711
TELEX : 517335 WULTEX G. FAX : (0484) 538273
A subsidiary of Becorit Holdings Limited

Manufacturers of Mining Equipment, Material Handling Systems, and Special Fabrications.

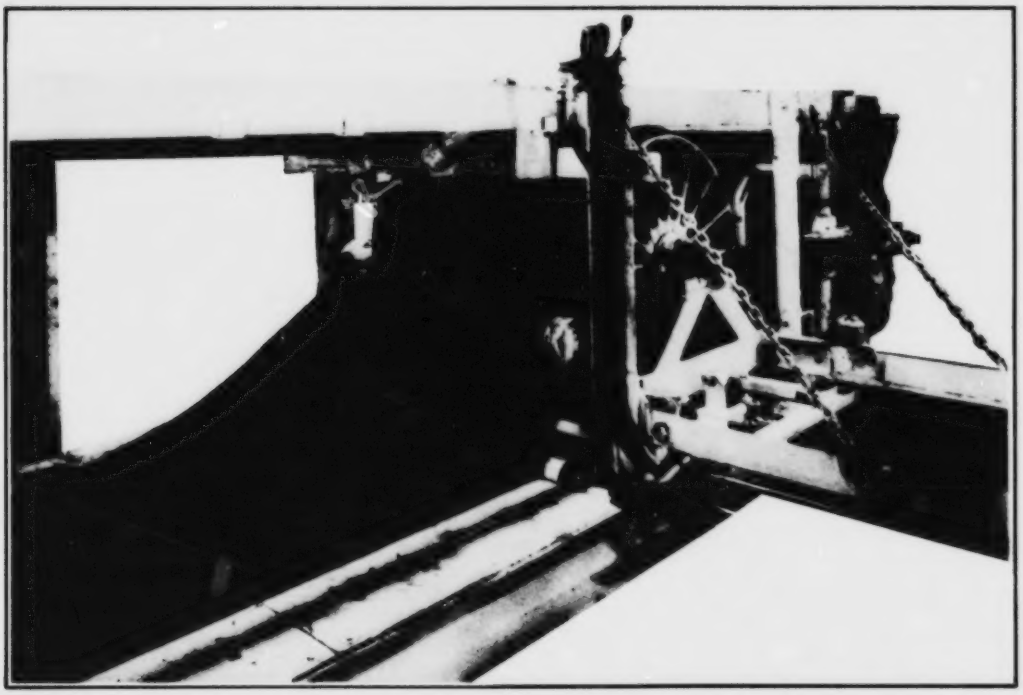
FLETCHER SUTCLIFFE WILD LTD.

MODULAR IN-SEAM CONVEYOR DRIVE UNIT

complete with belt take up/storage unit and
belt reel/maintenance station

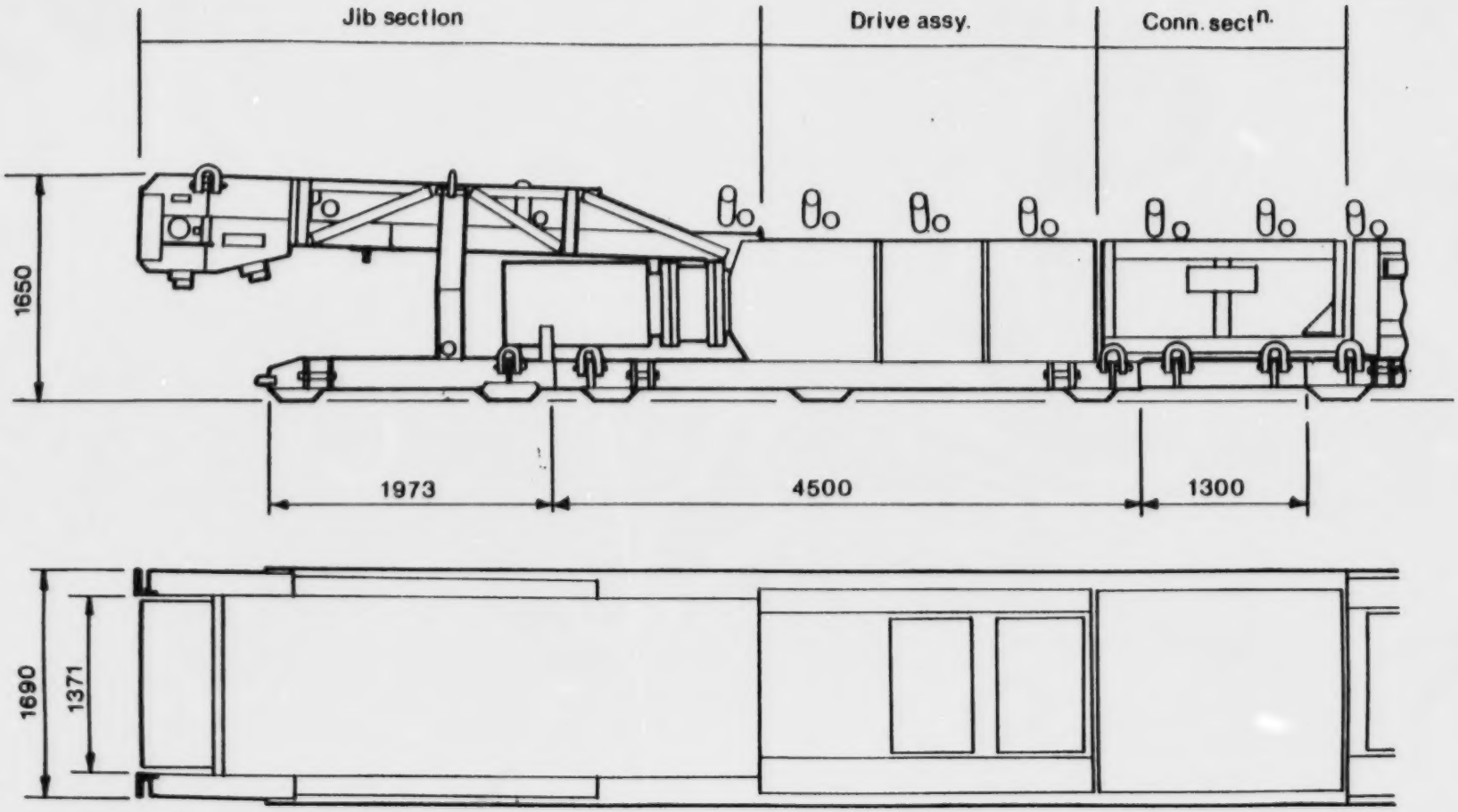


Modular drive – General view from front-end of unit



Belt reel / Maintenance station, fitted adjacent to take-up unit

DRIVEHEAD AND JIB



MODULAR IN-SEAM DRIVE UNIT

Complete with Automatic Take-Up/Belt Storage Unit and Belt Reel/Maintenance Station

New Design of In-Seam Conveyor Drive Unit

This new FSW In-Seam conveyor has been specially designed for rapid advancing or retreating applications and the first of these will be installed shortly at Wistow Colliery, Selby, N. Yorkshire Area of the NCB.

Basically, the design of the existing In-Seam type drive, delivery jib and take-up unit has been modified to an arrangement of modular skid mounted sections each approximately 4.5 metres in length with spigot locations secured by tapered pins for ease of assembly and installation. In addition, a belt reeling/maintenance station has been fitted adjacent to the loop take-up unit.

Each conveyor assembly therefore comprises of:-

Jib

Drivehead

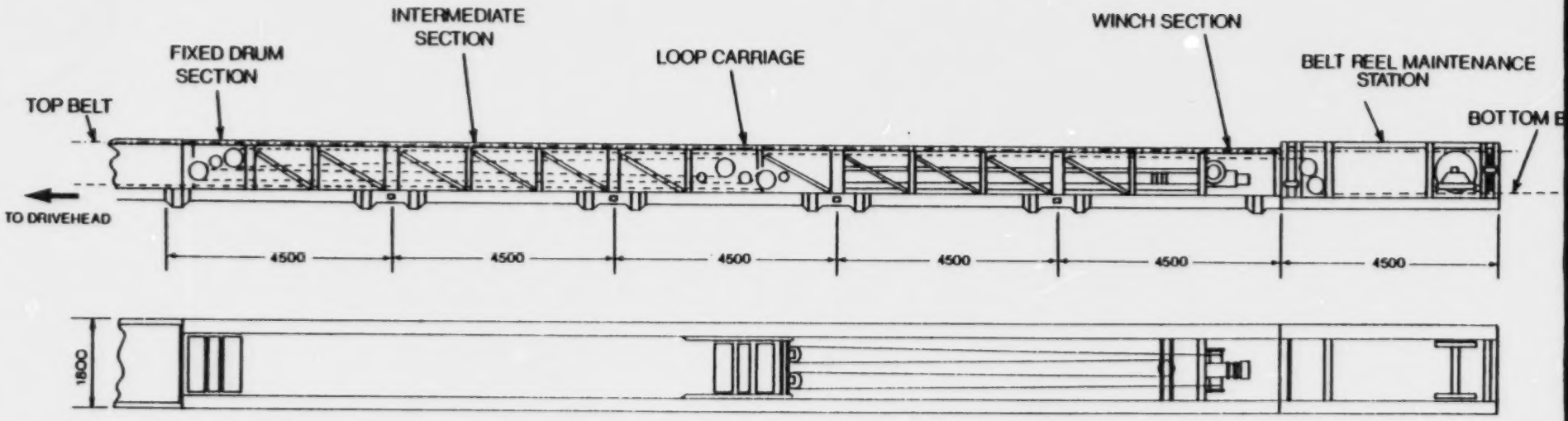
Connecting section

Automatic loop

Belt reeling/maintenance section

The initial design is a 112kW (150 HP) version with a single NCB spec. gearbox and motor fitted forward of the gearhead, underneath and in line with the jib section. A twin gearbox/motor - 2 x 112kW (300 HP) version, is currently being designed which will have the second gearbox/motor at the inbye end of the drivehead fitted underneath a lengthened connecting section to the loop.

BELT TAKE-UP/STORAGE UNIT & BELT REELING MAINTENANCE STATION



Current design is for 1050mm (42") belt width with belt speeds similar to the standard In-Seam drive and ranging from 1.85 m/sec (364 fpm) to 3.2 m/sec (630.fpm). 1200mm (48") belt widths are also being made available.

The loop section has 4 belt laps and houses 60 metres of belt, allowing for a 50 metre length of belt to be easily removed/installed. Additional designs to accept the removal/installation of up to 100 metres of belt on 4 lap and 6 lap storage units are currently being completed. The take-up unit is fully automatic and electrically operated utilising PIAB equipment.

The belt reel/maintenance station which is attached to the inbye end of the loop section is unique in design and belt can be installed or removed quickly and efficiently with minimum amount of manpower requirements. The main components of the station are

(a) Belt reel/maintenance section.

(b) Working table.

(c) Series of hydraulically operated top and bottom belt clamps.

The basic operation for removing belt is to fit an empty belt reel in the appropriate position in the station and by operating the hydraulic clamps (which are positioned at strategic points) to the top and bottom belts, the belt can be separated at a suitable joint on the work table. The loose end of the belt is then connected to the reel. Then by powering the take-up winch and reel, the belt is wound out onto the belt reel. When the required length has been removed the 'loaded' reel of belt is withdrawn by operating the hydraulic rams to traverse the reel from under the conveyor to a position for loading and despatch. When installing belt, the operation is similar but in reverse. The control is very simple and, more important, very safe since men are only working on a purposely designed working table with a minimum number of protection guards removed.

SEQUENCE OF OPERATION OF FSW BELT REEL

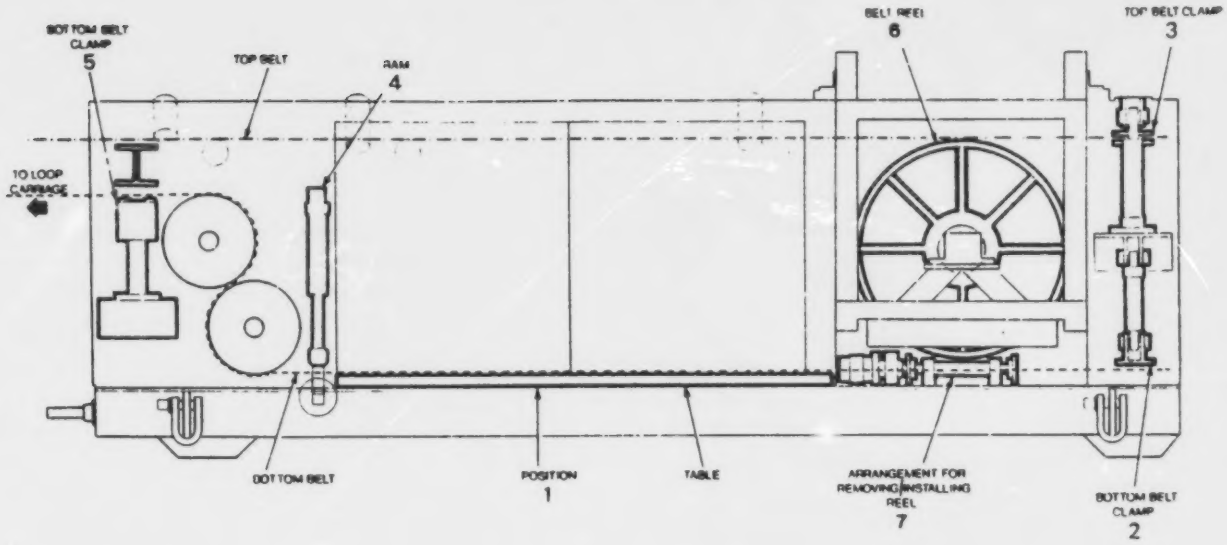
When working in conjunction with an FSW multi lap loop take-up unit.

Removing Belt

Limit switches will indicate when the loop is full, thus enabling 50 metres of belt to be removed.

1. Run the conveyor until a belt joint is conveniently positioned on the table area 1.
2. Clamp bottom belt by operating controls on the hydraulic rams at position 2.
3. Clamp top belt by operating similar controls at position 3.
4. Slack off loop carriage. Only a slight movement of approximately 200mm (8") is required.
5. Activate ram 4. This lifts a bottom roller which creates slack bottom belt (sufficient to uncouple at joint).
6. Clamp bottom belt by operating controls at position 5. The bottom belt is now clamped on each side of the slack belt in the working area.
7. Remove guards in table work area.
8. Remove the bottom belt joint pin (rod).
9. Attach the belt leader on the reel to the bottom belt joint.
10. Replace guards.
11. Slack off clamp by controls at 5.
12. Activate reel 6. This rotates but only pulls up the slack belt. (At this stage rotating force of the reel is not sufficient to overcome the power of the loop carriage winch). The bottom belt is now tight.
13. Operate loop carriage winch in reverse direction.
14. Reel will now rotate pulling out the bottom belt and thus pulling on the loop carriage and keeping the winch ropes tensioned.
15. When required belt length has been 'reeled' out, stop the loop carriage with bottom belt joint suitably positioned on work table.
16. Clamp bottom belt again by operating controls at 5.
17. Stop drive to reel 6.
18. Rotate reel in reverse just sufficiently to throw slack belt on to work table area.
19. Remove guards.
20. Remove bottom belt joint pin (rod).
21. Rotate reel to take up surplus belt.

BELT REEL MAINTENANCE STATION



22. Join up bottom belt with belt pin (rod).

23. Release clamps by controls at 5, 3, and 2.

24. Replace guards.

25. Re-activate loop winch (auto-mode).

Belt is now ready for running.

Full reel of belt can be removed at any suitable time by activating control 7 which pulls out the reel to a convenient space for loading.

Empty reel can then be installed in preparation for the next cycle.

Installing Belt

Operation is same as when removing belt except:-

(a) At the start of the sequence, the loop would be empty of belt.

(b) No power must be applied to the reel because this drive is faster than the loop winch drive.

Advantages

1. As with the basic design of In-Seam conveyor, the overall width is kept to an absolute minimum by having gearbox/motors housed underneath and within the conveyor width of 1800mm. An excellent feature giving maximum clearances for track-mounted or other wide type material supply vehicles.

2. Standard NCB specification AFC gearbox/motors are employed, which is advantageous with respect to spares holding requirements.

3. Easily and quickly installed - modular sections are readily fitted together by means of spigot location and secured by tapered pins and cotters.

4. An ideal unit for gate belt applications where units are continually being moved from district to district.

5. When incorporating the purposely designed belt maintenance station, shortening/extending of the belt and belt maintenance work generally is performed most efficiently.

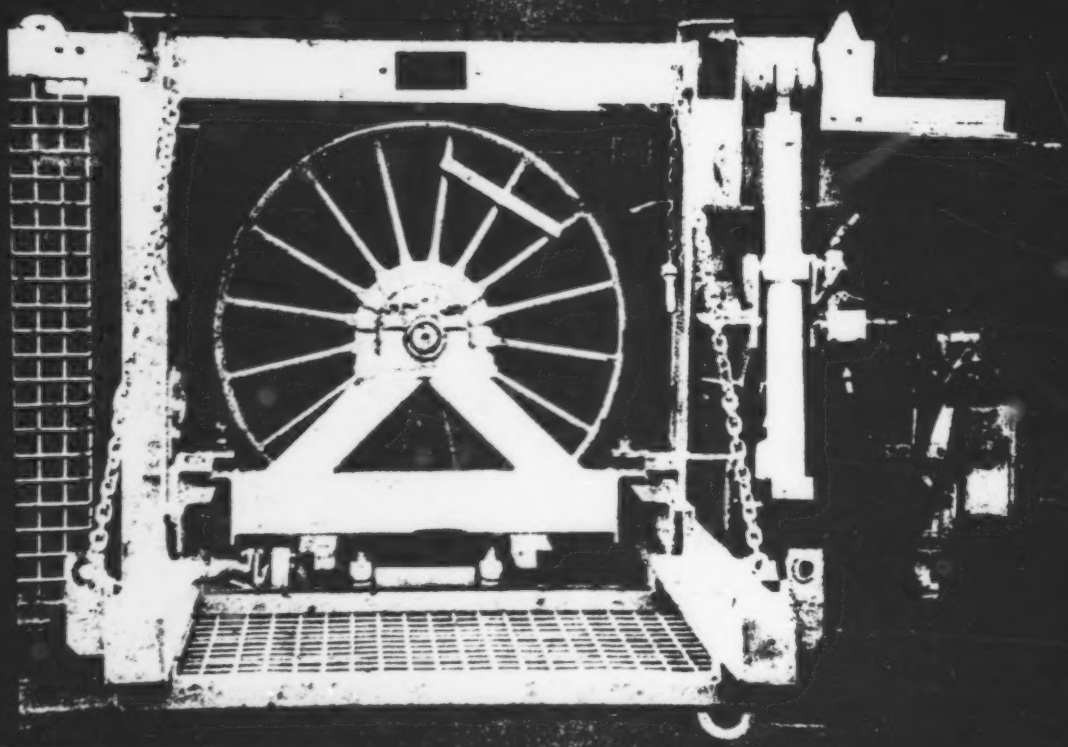
Summarising these advantages it can be seen that this unit is

PURPOSELY DESIGNED FOR DISTRICTS WHERE THE METHOD OF WORKING INCORPORATES RAPID RETREATING OR ADVANCING FACES RESULTING IN:-

(i) THE CONTINUAL NEED OF REMOVING OR ADDING BELT

(ii) DRIVES BEING REGULARLY RE-INSTALLED DUE TO SHORT-LIFE PANELS

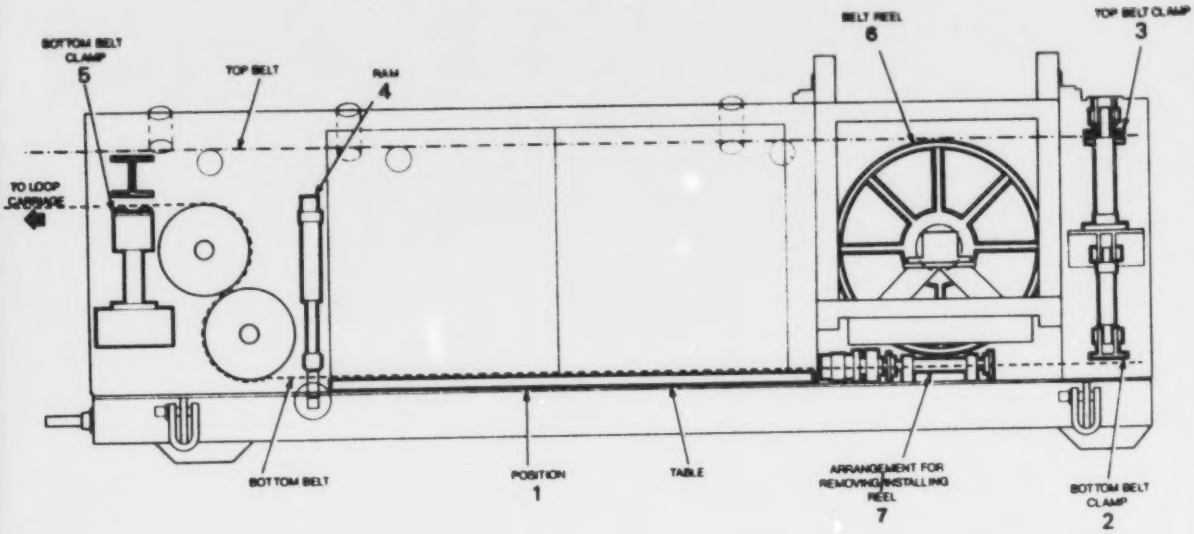
BELT REEL/MAINTENANCE STATION



PURPOSELY DESIGNED FOR INSTALLATIONS WHERE THE METHOD OF WORKING INCORPORATES A RAPID RETREATING OR ADVANCING FACE.

THE UNIT CATERS FOR THE CONTINUAL TASK OF REMOVING OR EXTENDING THE CONVEYOR BELT

BELT REEL MAINTENANCE STATION



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REMOVING BELT

Limit switches will indicate when the loop is full, thus enabling 50/100 metres of belt to be removed.

1. Run the conveyor until a belt joint is conveniently positioned on the table, (position **1.**)
2. Clamp bottom belt by operating controls on the hydraulic rams at position **2.**
3. Clamp top belt by operating similar controls at position **3.**
4. Slack off loop carriage. Only a slight movement of approximately 200mm (8") is required.
5. Activate ram **4.** This lifts a bottom roller which creates slack bottom belt (sufficient to uncouple at joint).
6. Clamp bottom belt by operating controls at position **5.** The bottom belt is now clamped on each side of the slack belt in the working area.
7. Remove guards in table work area.
8. Remove the bottom belt joint pin (rod).
9. Attach the belt leader on the reel to the bottom belt joint.
10. Replace guards.
11. Slack off bottom belt clamp by controls at **5.**
12. Activate reel **6.** This rotates but only pulls up the slack belt. (At this stage rotating force of the reel is not sufficient to overcome the power of the loop carriage winch). The bottom belt is now tight.
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Empty reel can then be installed in preparation for the next cycle.

Installing Belt

Operating is same as when removing belt except:-

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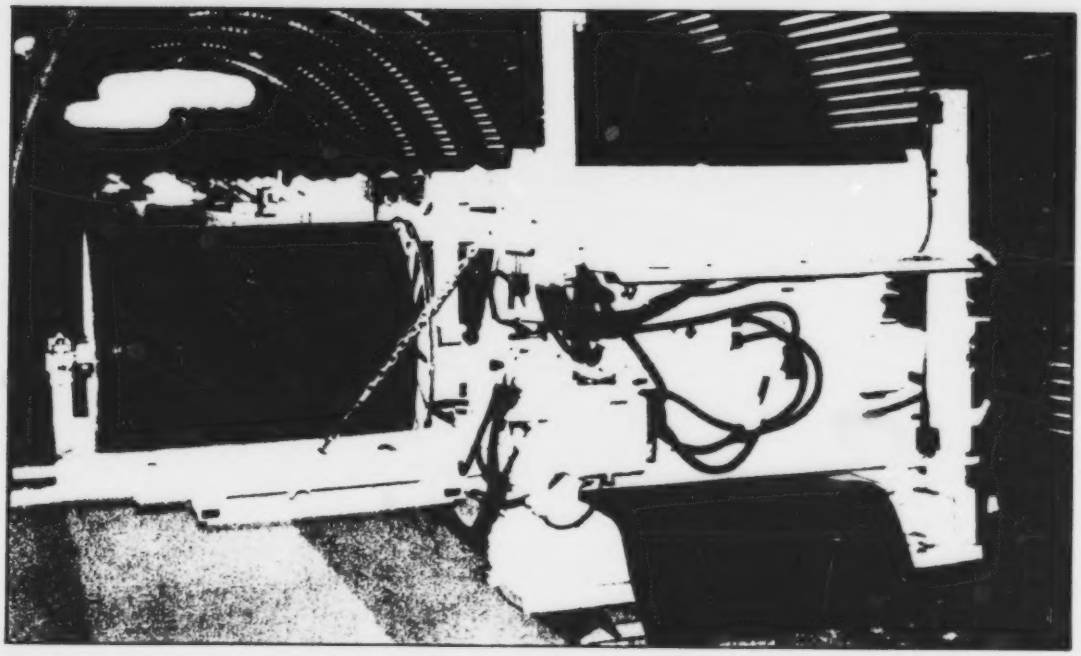


FEATURES

* RAPID AND EASY TO OPERATE — TRIALS HAVE SHOWN THAT TWO MEN CAN EXTRACT 50 METRES OF BELT IN 15 MINUTES.

* OPERATION ENSURES THAT LONG LENGTHS OF BELT ARE INSTALLED i.e. AVOIDING NUMEROUS SHORT LENGTHS OF BELT AND JOINTING.

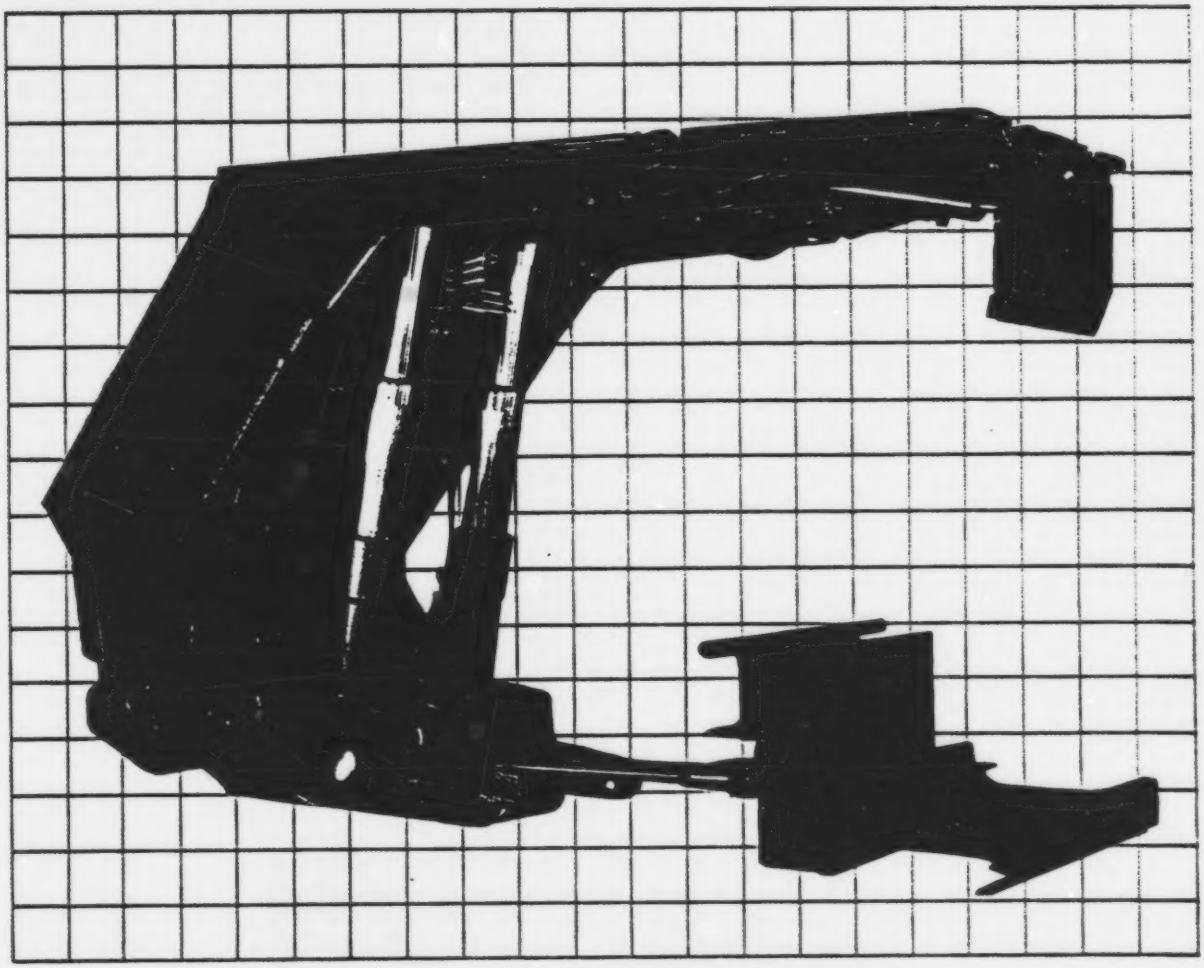
* IDEAL FOR INSTALLING BEHIND THE FSW MODULAR IN-SEAM DRIVE UNIT FOR EASE OF DISMANTLING AND ERECTION OF SHORT LIFE WORKING FACES

FSW

HEMSCHEIDT AMERICA CORPORATION

SHIELD SUPPORT FOR MEDIUM SEAMS

Type G 320-12/27



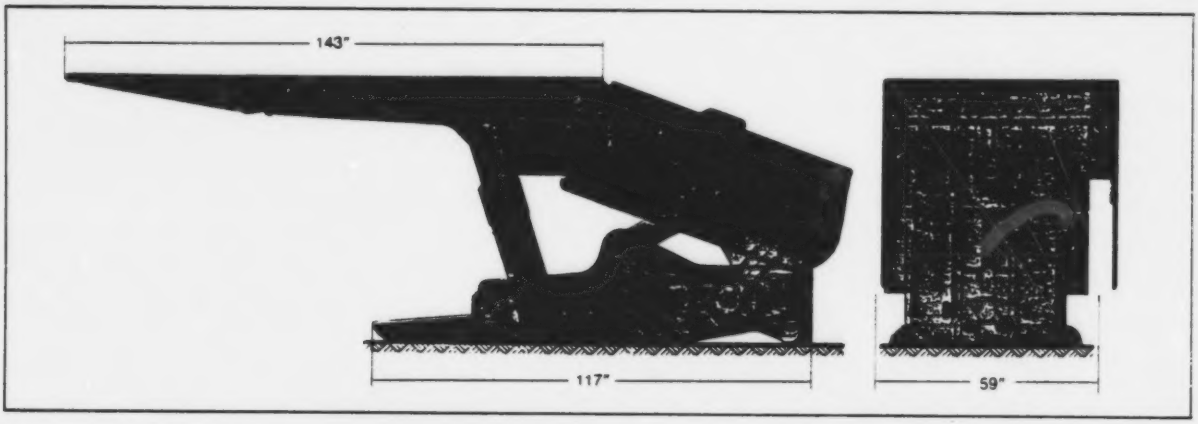
HEMSCHEIDT

SHIELD SUPPORT FOR MEDIUM SEAMS

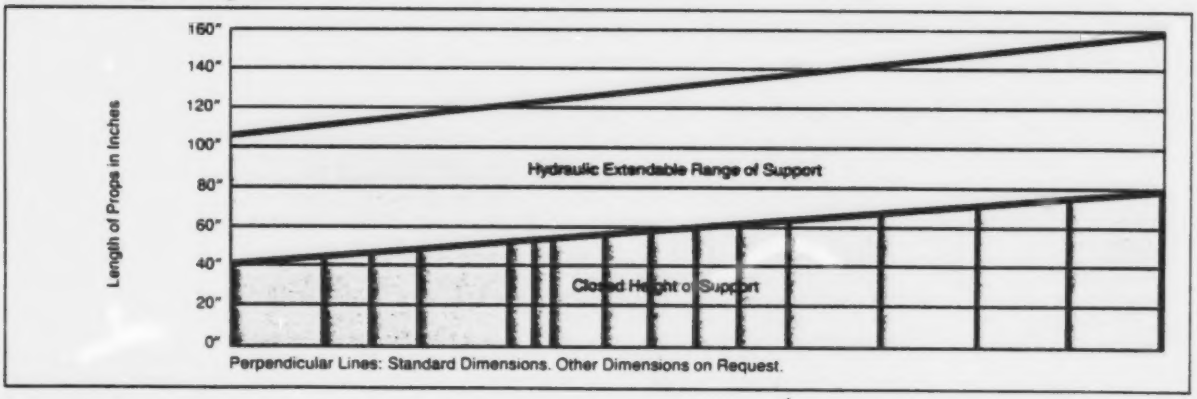
Technical Details

Type of Support	G 320-12/27
Support Height Closed Open	 47″ 106″
Prop Type Setting Load Yield Load	Double Telescopic—VHED 1600/2 137 tons 180 tons
Support Resistance Maximum	 5.4 tons/ft²
D. A. Ram Assembly Conveyor Push Support Advance	 19 tons 38 tons

Dimensions



Operating Range

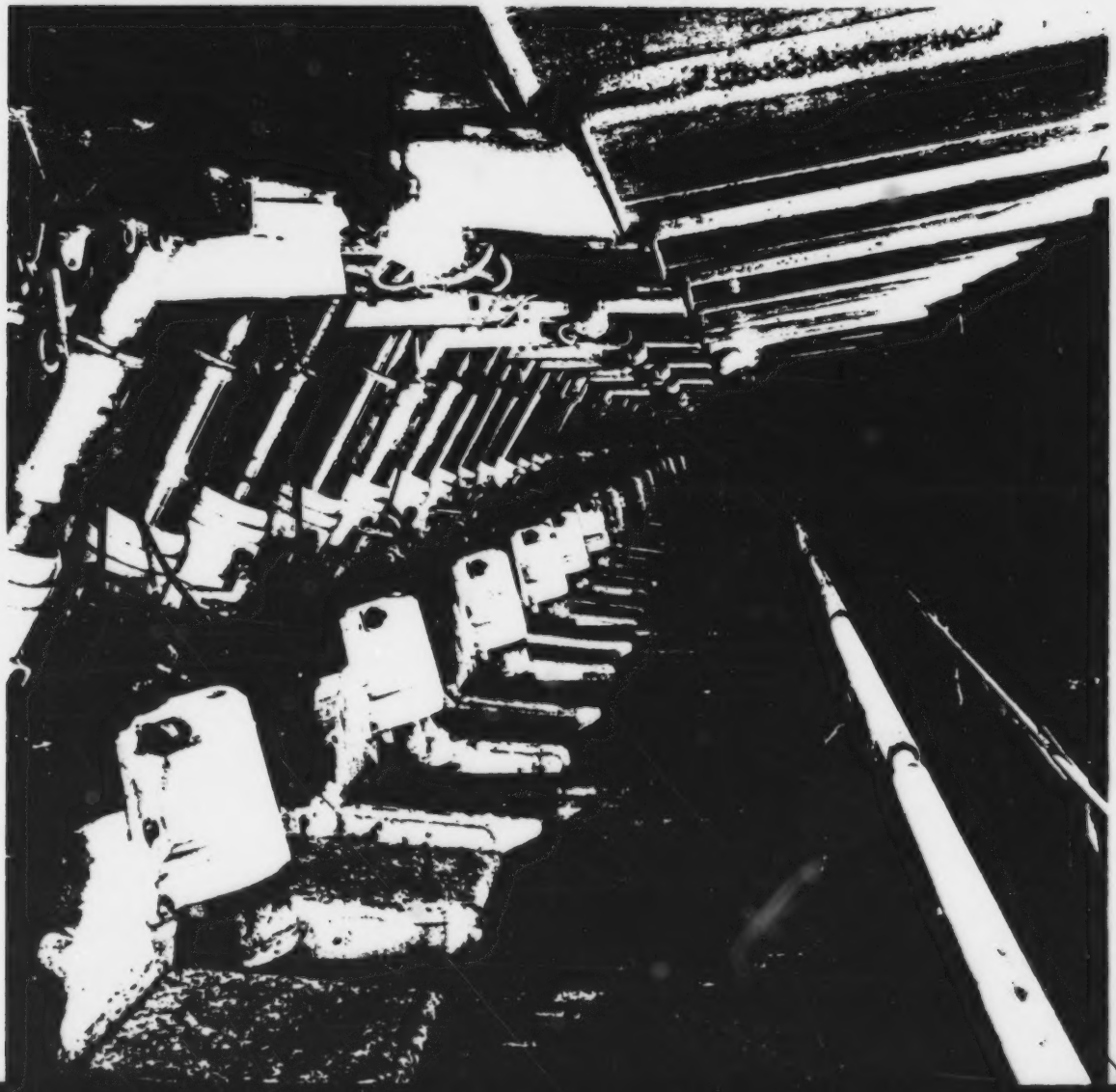


HEMSCHEIDT AMERICA CORPORATION
Suite 536, Manor Oak No. 2, Pittsburgh, PA 15220 • Telephone: 412/~~563-0580~~ 787-7130 Telex: 86-6437

10M 10-82

2 Leg Shields

GULLICK INTERNATIONAL



2 Leg Shields

High output and modern longwall mining go hand in hand; Gullick Dobson 2 leg shields fit right in because there's one that is suited to any job, thin, medium, thick seams. Yield load to 660 U.S. tons. You can match a Gullick 2 leg shield safely and economically to any longwall requirement.

BASE

The base skids, of catamaran design, extend forward to produce low floor loading characteristics. The low profile of the skids maximize travelway. For soft floor conditions, a base-lifting ram is available. The ramming system used is the "Reverse Thrust" layout, providing maximum force to advance the support and face conveyor.

LEGS

Single or double telescopic legs are available through a wide working range. High yield steel tubing is used for the cylinders. For maximum corrosion protection inner members and cylinders may be either bronze or chrome-on-bronze plated. Piston seals and gland seals are the solid ring, synthetic rubber type which has a proven record of reliability for mining applications.

GOB SHIELD

A rigid rear shield structure interconnects the canopy and base via wide links which absorb roof forces and protect the legs from all bending forces. The design and inclination of the rear shield enables heavy caving to be handled without structural damage and with maximum stability.

CANOPY

Rigid slimline one-piece canopies maximize machine clearance for either conventional or Immediate Forward Support operation. The canopy can be extended to accommodate a wider web.

SIDE SHIELDS

The supports can have integrated canopy and rear side shielding. One side is activated hydraulically, or by springs, to provide inter-support contact.

CONTROLS

The proven Gullick Phase 5 control system can provide simple unit control through adjacent control to fully electrically initiated remote control with the Electroflex system.

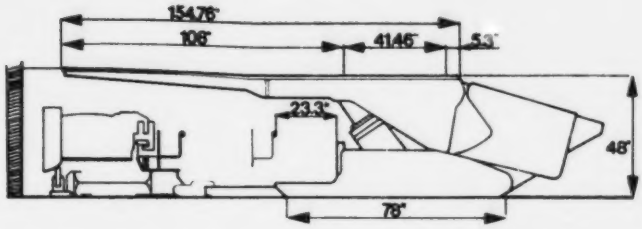
GULLICK HAVE THE ANSWERS

There's a Gullick support and control system to answer the challenge of any seam. In addition, Gullick supply an entire range of props, pumps, tanks, piping, accumulators and valves for both local and remote pumping stations. Gullick Dobson's after-sale follow-up and technical

SPECIFICATION

2 LEG 580 U.S. TONS SHIELD SUPPORT

Mode of Operation I.F.S.

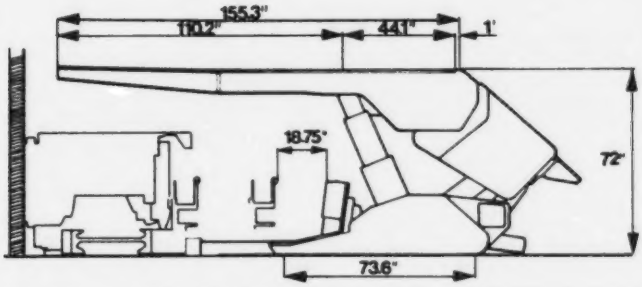


	METRIC	U.S.
Height Range	813-1778 mm	32-70 ins
Support Centres	1511 mm	59·5 ins
Leg Load:		
At Setting (4,500 psi)	201·8 tonnes	222·5 tons
At Yield	290·3 tonnes	320 tons
Vertical Roof Load (max)	531·2 tonnes	585·6 tons
Tip Load	148·3 tonnes	163·5 tons
Cave Load	382·9 tonnes	422·1 tons
Support Density (at set)	56·2 t/m^2	5·76 t/ft^2
Support Density (at yield)	80·85 t/m^2	8·28 t/ft^2
Floor Pressure (av)	237·7 t/m^2	24·34 t/ft^2
Conveyor Advance Load	13·97 tonnes	15·41 tons
Support Advance Load	38·83 tonnes	42·8 tons

SPECIFICATION

2 LEG 550 U.S. TONS SHIELD SUPPORT

Mode of Operation I.F.S.

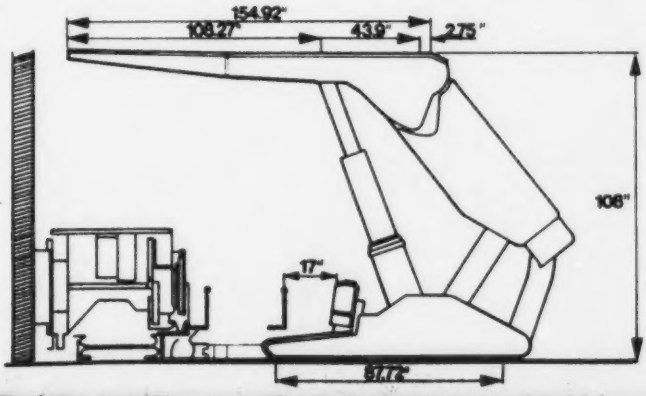


	METRIC	U.S.
Height Range	965-2032 mm	38-80 ins
Support Centres	1500 mm	59 ins
Leg Load:		
At Setting (4,500 psi)	201·8 tonnes	222·5 tons
At Yield	251·3 tonnes	277 tons
Vertical Roof Load (max)	500·5 tonnes	551·7 tons
Tip Load	129·5 tonnes	142·8 tons
Cave Load	370·9 tonnes	408·9 tons
Support Density (at set)	62·2 t/m^2	6·37 t/ft^2
Support Density (at yield)	77·43 t/m^2	7·93 t/ft^2
Floor Pressure (av)	238·84 t/m^2	24·46 t/ft^2
Conveyor Advance Load	13·97 tonnes	15·41 tons
Support Advance Load	38·83 tonnes	42·8 tons

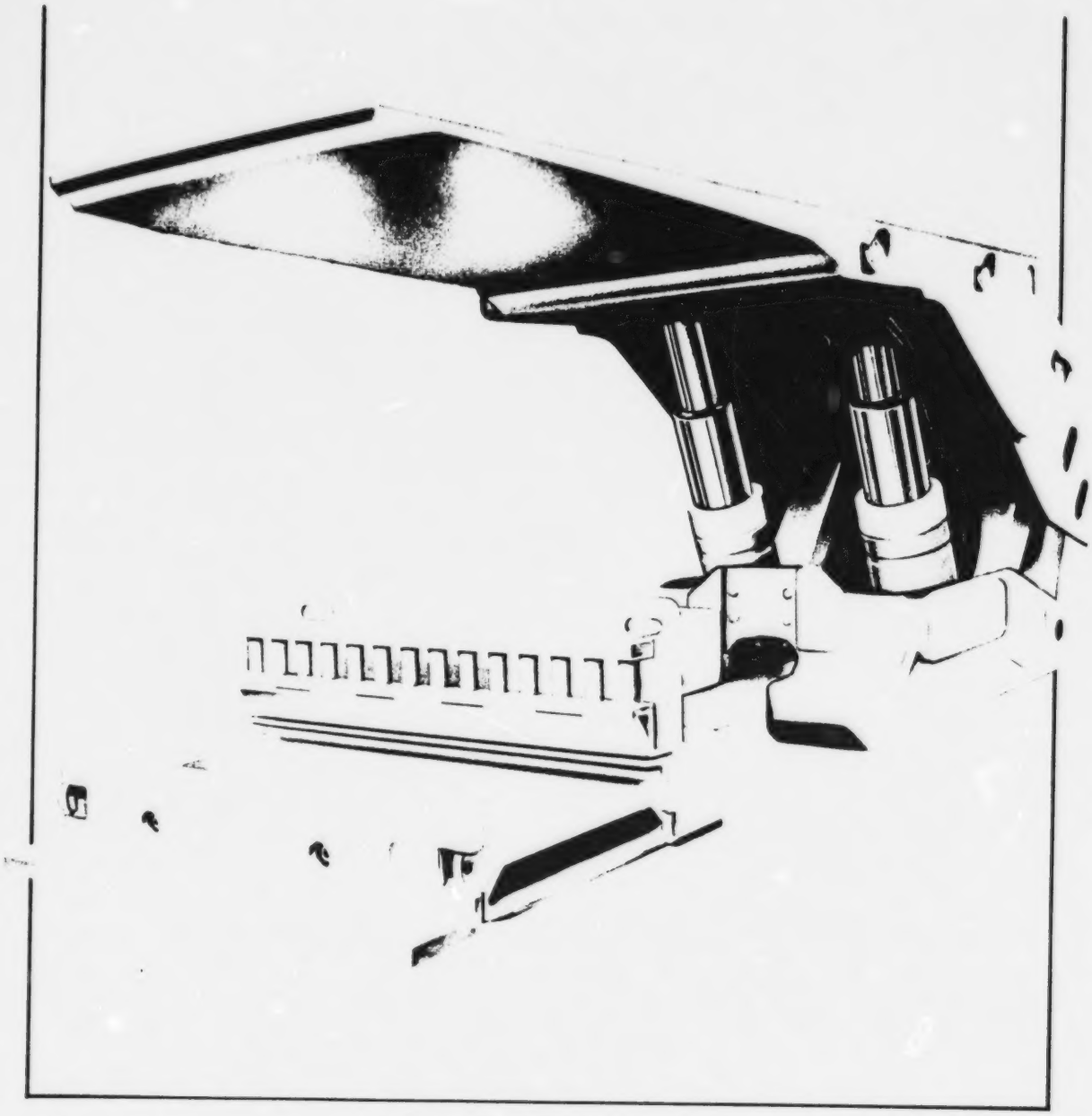
SPECIFICATION

2 LEG 650 U.S. TONS SHIELD SUPPORT

Mode of Operation I.F.S.



	METRIC	U.S.
Height Range	1067-2743 mm	42-108 ins
Support Centres	1500 mm	59 ins
Leg Load:		
At Setting (4,500 psi)	201·8 tonnes	222·49 tons
At Yield	301·2 tonnes	332 tons
Vertical Roof Load (max)	588·1 tonnes	648·3 tons
Tip Load	161·7 tonnes	178·3 tons
Cave Load	426·4 tonnes	470 tons
Support Density (at set)	60·9 t/m^2	6·24 t/ft^2
Support Density (at yield)	90·9 t/m^2	9·31 t/ft^2
Floor Pressure (av)	236·8 t/m^2	24·25 t/ft^2
Conveyor Advance Load	13·98 tonnes	15·41 tons
Support Advance Load	38·83 tonnes	42·8 tons



Leadership in the world of mining.

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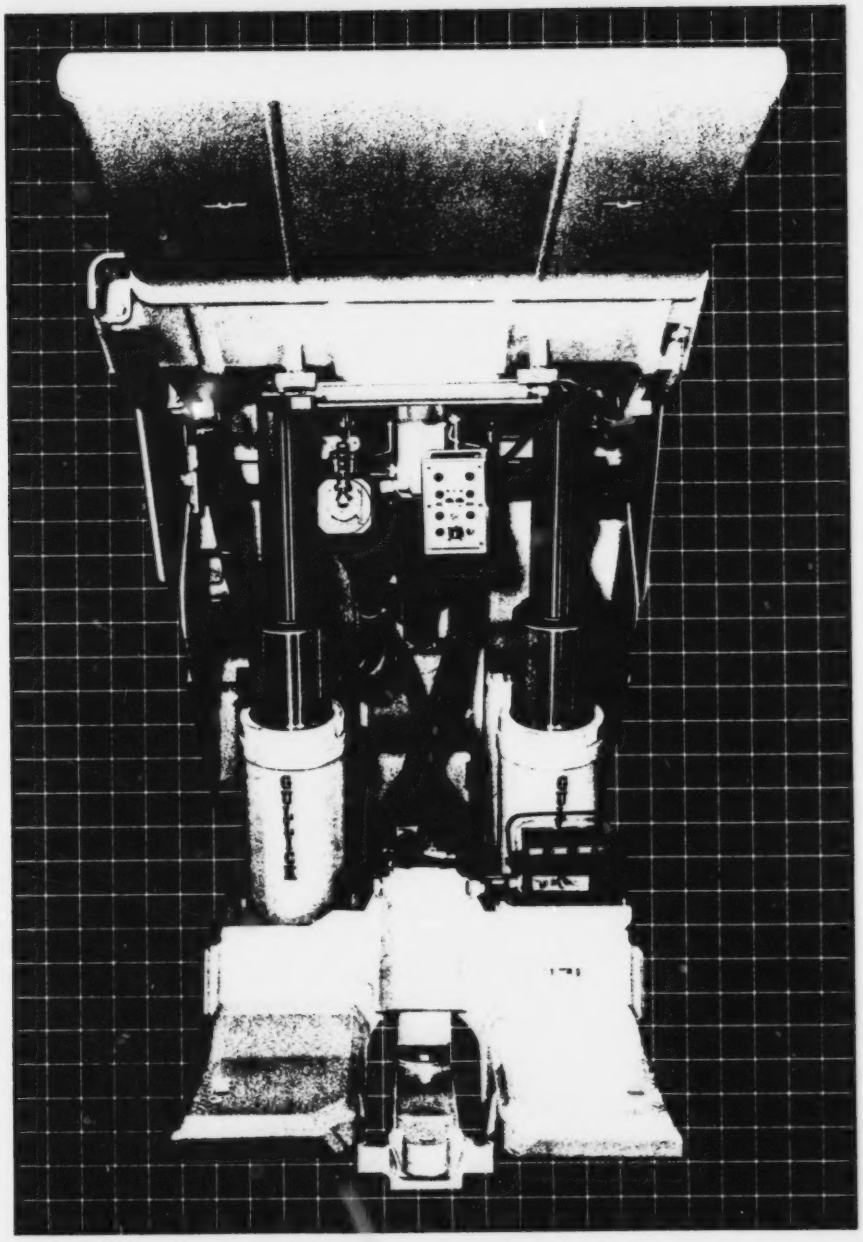
Members of the Dobson Park Industries Group

"Electroflex"

LOW POWER, HIGH TECHNOLOGY ROOF SUPPORT CONTROL.



GULLICK DOBSON

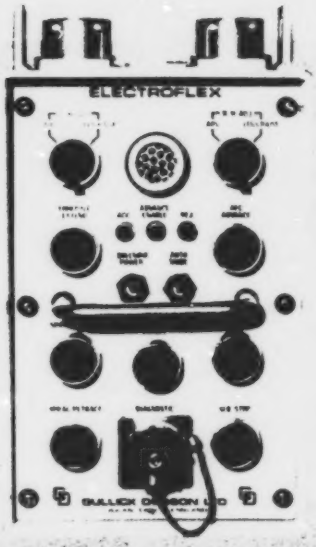
"Electroflex" The W support control system.

THE GULLICK DOBSON "Electroflex" Control System is microprocessor based and utilises low power electro-hydraulic interface valves to give the maximum possible flexibility and reliability from an intrinsically safe roof support control system.

▷ LOW POWER TECHNOLOGY.

Using a low power interface valve developed by Gullick Dobson, which absorbs only a 10 milliamp current at 12 volts, replacing the 90/100 milliamp solenoids previously used in electro-hydraulic systems.

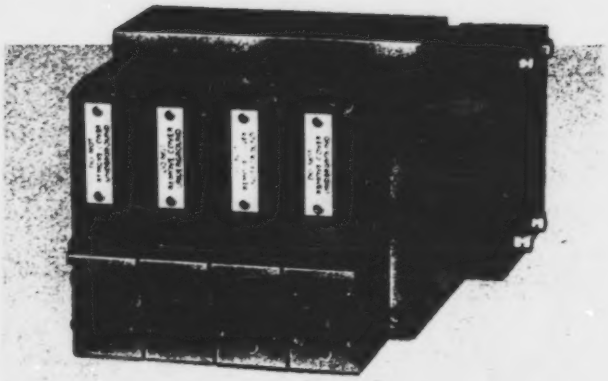
This obviously offers maximum flexibility and reliability within the 500 milliamp limit for intrinsically safe equipment, with up to 20 functions being possible on a face at any one time, as compared to the previous 2 or 3 functions.



The "on face" microcomputer which is used for local control of up to 6 functions and the "on face" push button initiation of automatic sequences.

▷ FULLY MICROPROCESSOR BASED.

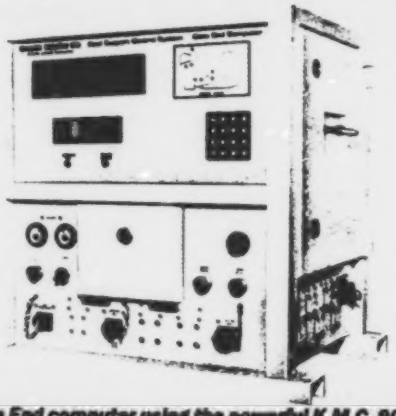
This low power technology, linked to both "on face" and "face end" microprocessors, offers the maximum in versatility and finesse in the control of roof supports to improve production and productivity on longwall



Motorised Valve Pack.

▷ PIT PROVEN, ROBUST DESIGN.

All of this low power, microprocessor based, technology is provided using pit proven, robustly designed equipment which can be programmed to suit the requirements of all conventionally or I.F.S. operated longwall faces.



Gate End computer using the powerful K.M.C. 8000 microprocessor, manufactured by Instem, p.l.c., an associate company.

Software to give both "on face" push button control and "machine initiated" automatic operation can be provided.

▷ LOCAL CONTROL.

Push button operation of up to six functions.

1 Conveyor advance
2 Bi-Di adjacent support advance
3 Bi-Di adjacent support reset
4 Face sprag set
5 Face sprag retract (including extension bar retract if desired)
6 Extension bar set

orlds most advanced roof

▷ AUTOMATIC, SEQUENCE CONTROL.

Two, three or five function automatic Bi-Di sequence control, initiated "on face" or linked to machine position and speed.

2 FUNCTION *Conveyor advance, support advance and reset.*
3 FUNCTION *Conveyor advance, support advance and reset, Extension bar set.*
5 FUNCTION *Conveyor advance, support advance and reset, Extension bar set, Sprag set, Sprag retract.*

▷ ON FACE REPROGRAMMING.

The face end computer can be reprogrammed in SITU to vary operating headways, etc.,

▷ HYDRAULIC SIMPLICITY.

Hydraulic simplicity is achieved due to the use of low power interface valves:–

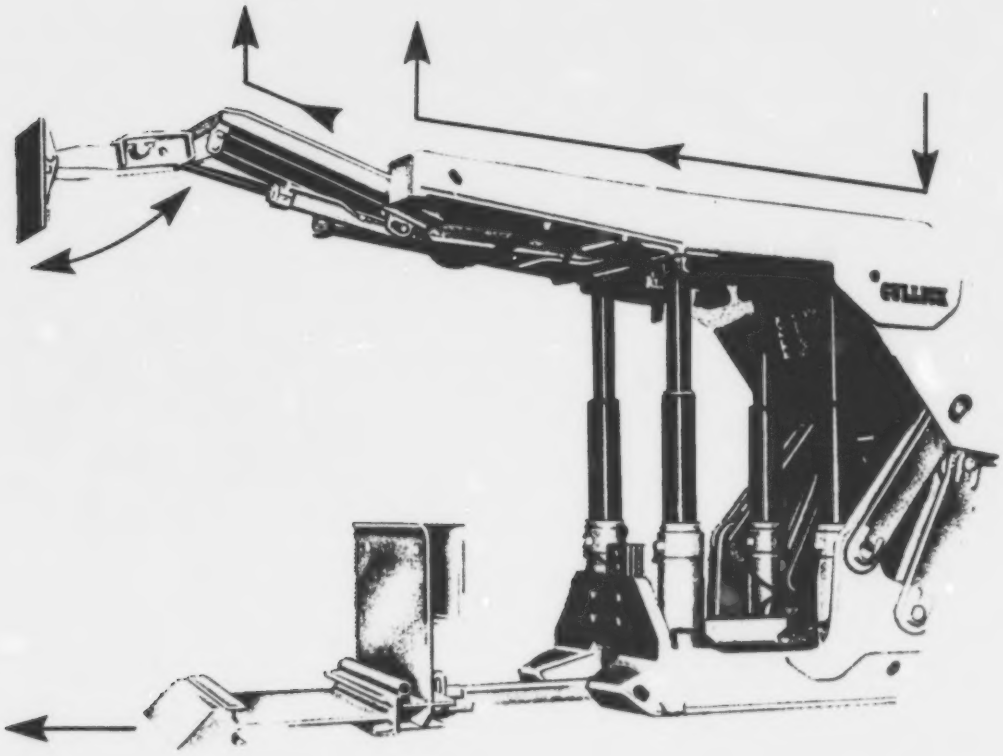
No hydraulic latching valves necessary.

"Time Outs" allow proper setting without positive set valves.

"Time Outs" allow full conveyor push.

Simplified and combined hydraulic valves reduce hoses and complication.

Full hydraulic overrides available from the minimum of handles (one in most cases).



"Electroflex"
aids to production and productivity.

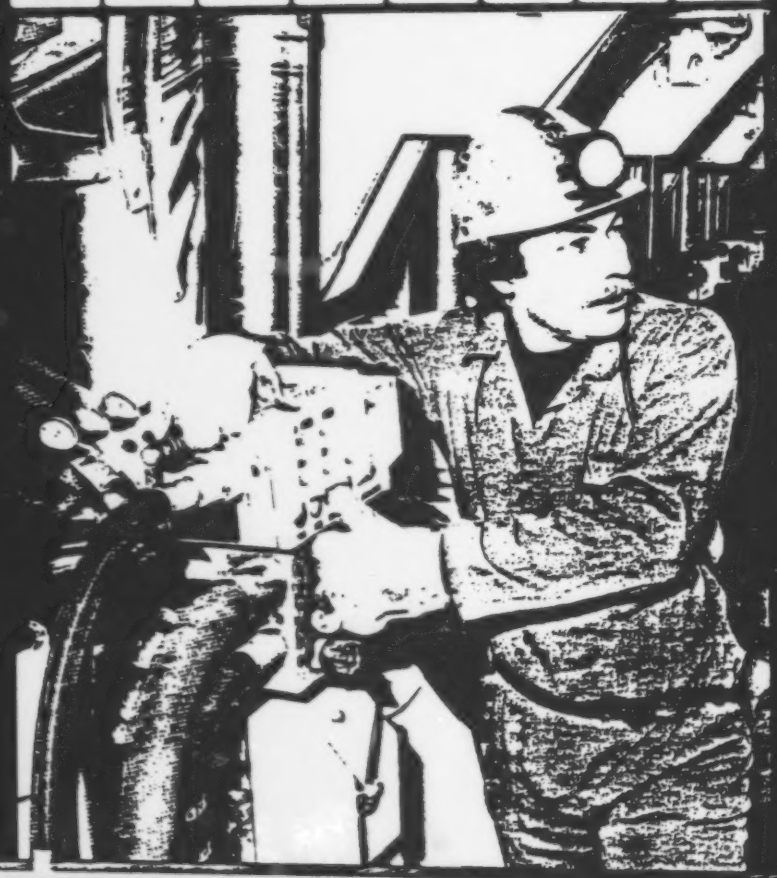
1. Faster speeds of operation, local or remote.
2. Less operator fatigue.
3. Consistent setting loads improve roof control.
4. Consistent and enhanced web depth with conveyor pushing.
5. The system fills in missed operations, such as conveyor push, extension bar and sprag setting, improving general strata control and web depth.
6. No operator back tracking to refresh, the computer stores instructions.
7. The powerful KM 8000 microprocessor can be programmed to suit all longwall systems to give maximum operator effectiveness and protection from environmental problems.
8. Management information at the computer, aids planning.
9. Supports can be checked and reset from the face end.
10. Manpower reductions.

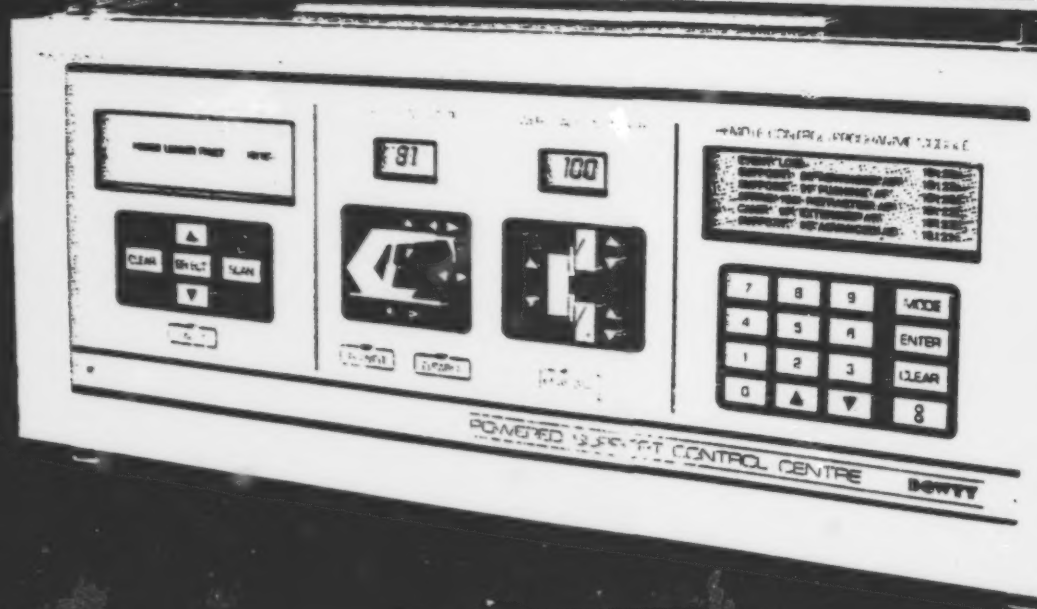
4 leg, 370 Tonne Chock Shield Supports underground in a North Nottinghamshire Colliery.
These supports are controlled by the Electroflex Control System (photograph by courtesy of National Coal Board).

Gullick Dobson Ltd., PO Box 12
Wigan Lancashire WN1 3DD England
Telephone: Wigan (0942) 41991 Telex: 67513

GULLICK DOBSON

ELECTRONIC CONTROLS





DOWTY

ELECTRONIC CONTROLS

Flexibility

All systems provide fully bi-directional remote control on either one web back, or conventional systems. Adjacent control is also fitted as standard for difficult conditions.

Speed of operation

Support and conveyor advance operations take place while the operator is travelling through the face. The speed of operation is therefore dictated only by the hydraulic response of the system. Alternatively, support operations can be automatically initiated from the shearer.

Positive setting continues for 15 seconds after the advance cycle is complete. The next support can therefore, be advanced while the previous unit continues to set up to pump pressure. The sequence is not delayed due to system pressure drops.

Improved roof control

One condition of operation is that before a support can be advanced, both adjacent supports must be set to the roof. This feature, coupled with automatic positive setting, ensures total roof control throughout the face.

Improved web alignment

All supports advance sequentially the AFC. Conveyor pull back, due to support advance is, therefore, minimised. Smooth progressive snaking also eliminates system pressure drops associated with bank push systems and applies an evenly distributed load on the AFC.

Simplicity of operation

All supports on the face are identical. Master/slave operations used in batch control are not employed.

The operator is kept fully informed (remote indications) on the progress of the advancing support. Indication is also given on the set/lowered condition of each support and supports can be corrected manually (from the adjacent support) if required. The adjacent control is independent of the automatic and semi-automatic systems.

Safety

A degree of safety can be built into electronic systems, which cannot be achieved on all hydraulic or mixed systems.

Principal features are:

1 A minimum number of operators are required in the working area.

2 Operators are provided with both audible and visible indication of impending support movement.

3 Fail safe emergency stops are provided on every unit for the protection of operators. Any stop button will stop all support movement.

4 Operators can station themselves on the clean side of the machine.

5 The control system is intrinsically safe. The total system demand is only 12 volt 0.5A, so that no special precautions are required for either the operation or maintenance of the system.

6 The control system is immune from noise and is designed to fail safe. Ghost operation of supports or groups of supports is not possible, since only one support at a time is initiated. Full fail safe operation is not possible on all hydraulic or mixed systems.

Reliability

System reliability is excellent and is achieved as follows:

1 The only moving parts in the system are the solenoid valves and two pressure switches, compared with some hydraulic batch systems which have as many as 10 sequence valves per support, all of which are susceptible to dirt, erosion and system pressure variations.

2 System components are minimised, particularly interchock hoses.

3 The interchock cable is built to the same degree of reliability as interchock hoses, i.e. the cores are protected by a double wire braid hose terminated in sealed staple fitting connectors. These connectors have been designed specifically for support control systems and are unique to Dowty.

4 The control unit is fully sealed and will resist total immersion in water. Other design parameters include immunity to shock and vibration.

Maintenance

Underground experience has shown that system maintenance is low. When required, maintenance is based on unit exchange. Since all the control electronics are contained in one unit, which can be changed in minutes, system downtime is minimised. Faults on supports can easily be identified from information given on the solenoid lamps and other monitors. Solenoid valve and pressure switch failures are rare, but should they occur, these items can also be changed quickly.

SYSTEMS AVAILABLE

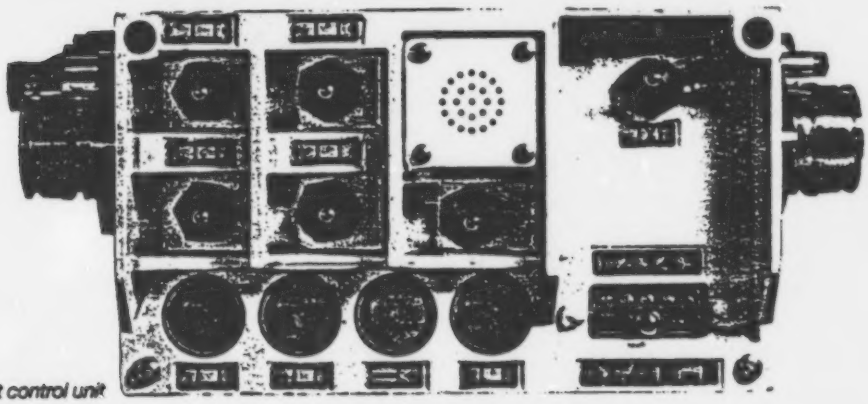
1 Shearer initiation (see note)
Movement of the shearer automatically initiates advance of the supports and AFC.

2 Remote push button control
This system permits limited range remote operation of up to four support functions by one operator. These functions can be operated independently of each other from any support using push buttons located on the operators support.

3 Free running batch controls
Automatic sequences can be initiated by a single operation of a control button. These sequences will move automatically towards the operator up to and including the support adjacent to the operator's support.

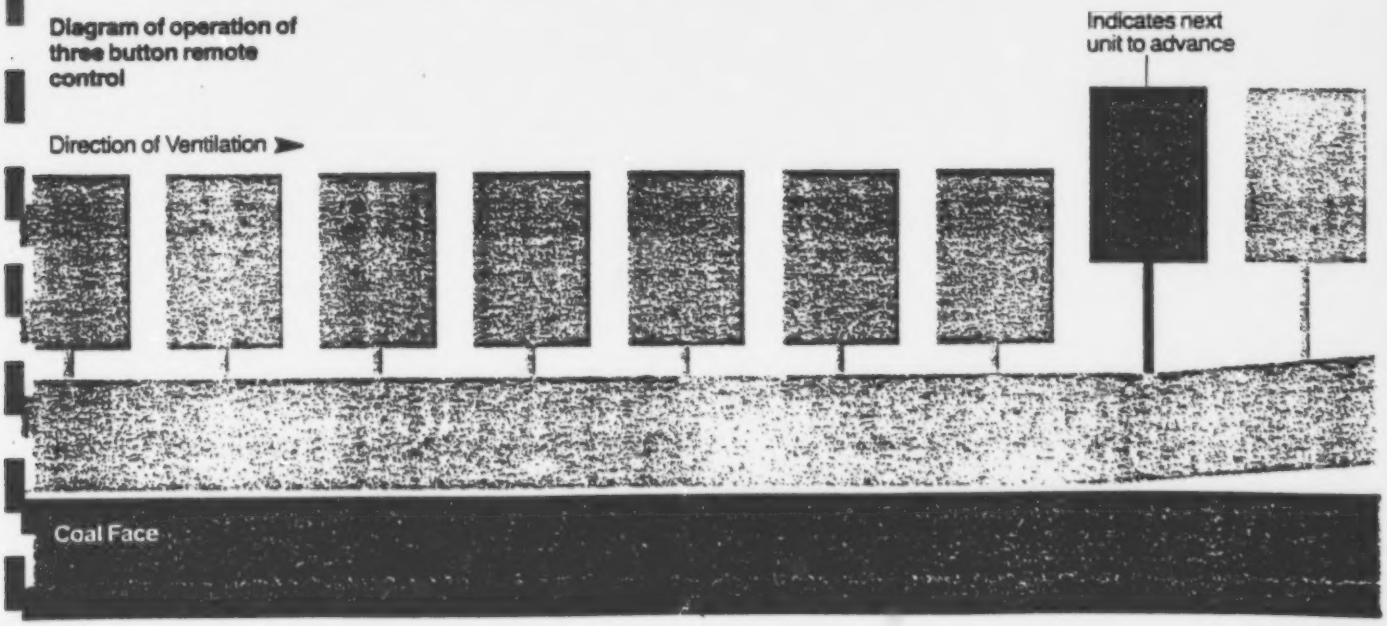
4 Remote manual control
Individual supports can be operated from the face end control station. This feature is used primarily to remotely correct the condition of supports prior to operating a coaling sequence.

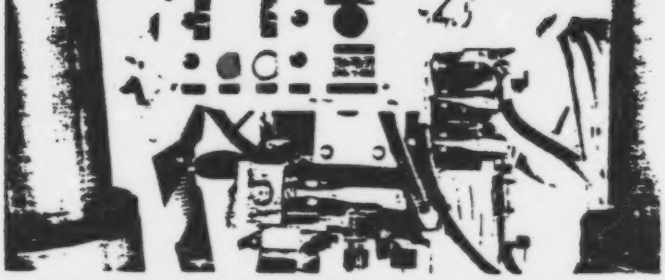
5 Bi-directional adjacent control
Direct (hard wired) operation of solenoid valves provides this back up system for use in difficult mining conditions.



Support control unit

Diagram of operation of three button remote control



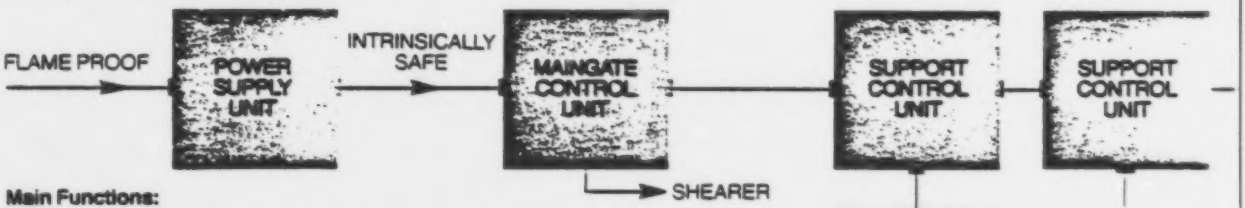


6 Individual hydraulic control of support services is available via the local manual control valves for maintenance operations.

7 **Special customer options**
Where standard systems are unsuitable for particular mining methods, special control software can be supplied to meet customer specifications.

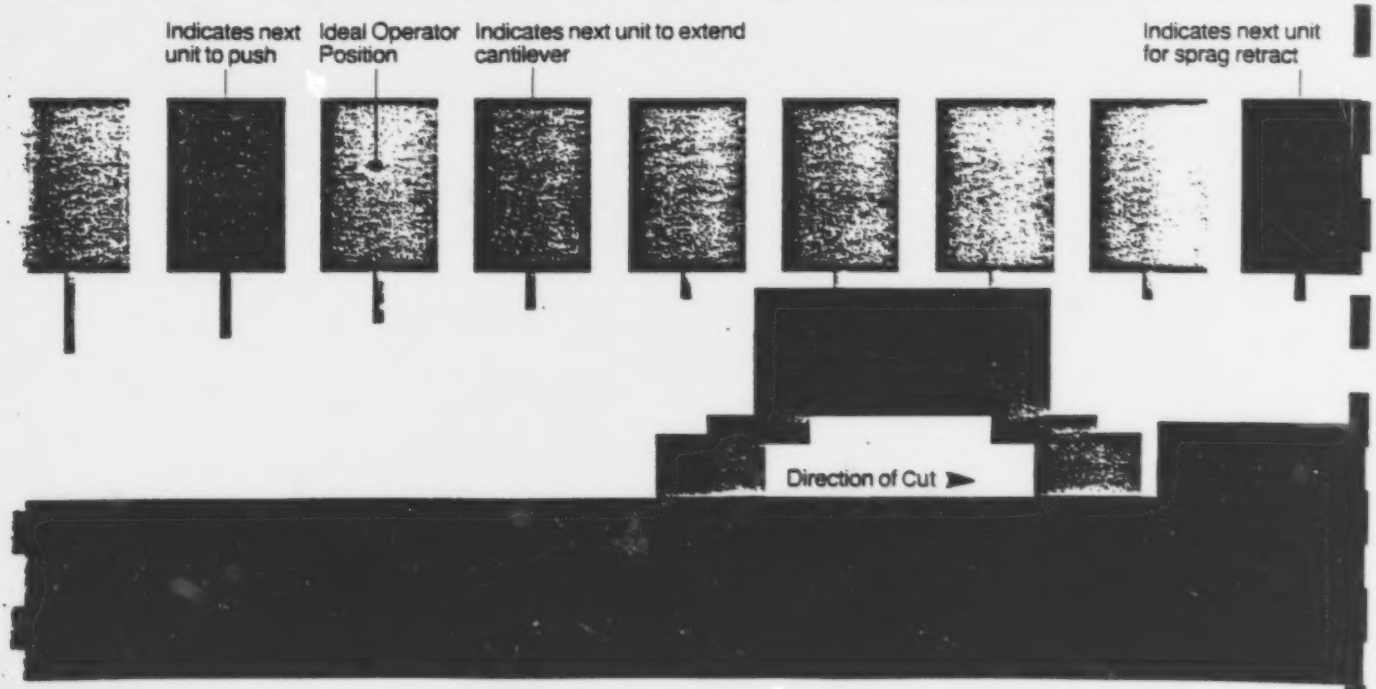
Note
On shearer initiated systems, shearer location can be determined either by using the shearer manufacturer's odometer system or by Dowty's infra-red location system. This is independent of shearer type and can be retrofitted to any shearer/support combination.

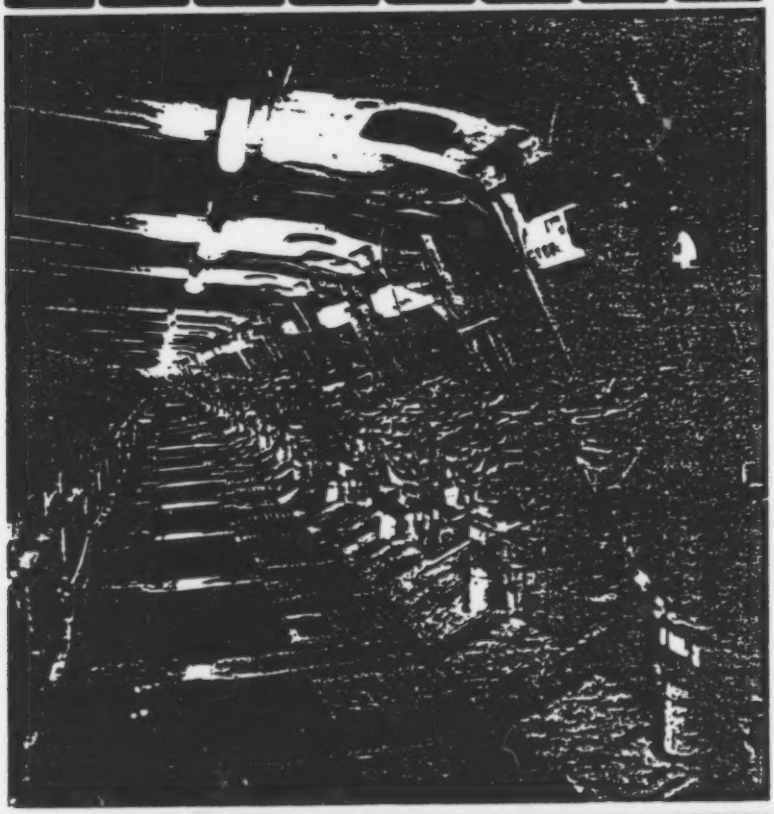
Microprocessor control system



Main Functions:

1 Bi-directional remote control
2 Bi-directional adjacent control
3 End of face information – Maingate – Support – Shearer
4 Machine initiation of supports
5 Batch control
6 Remote set
7 Customer options





Dowty 2/500 tons shield supports with electro-hydraulic Dowval control system at Consol's Loveridge Mine 22, West Virginia, USA

Dowty 4/650 tonnes chock shield supports with electronic control system at Angus Place Colliery, New South Wales, Australia

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Dowty Wolleng Pty. Limited
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241 Fuchs Street, Alrode Ext 2, PO Box 3924,
Alrode 1451, South Africa
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Dowty Mining Division companies

The policy of the company is one of continuous improvement in design. Specification of items may, therefore, be changed without notice.

THE QUEEN'S AWARD TO INDUSTRY 1967, 1968, 1973, 1978, 1980, 1981

DM/231/3/3000/R/FF

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Printed in England

EIMCO

TECHNICAL DATA

FOR THE

913

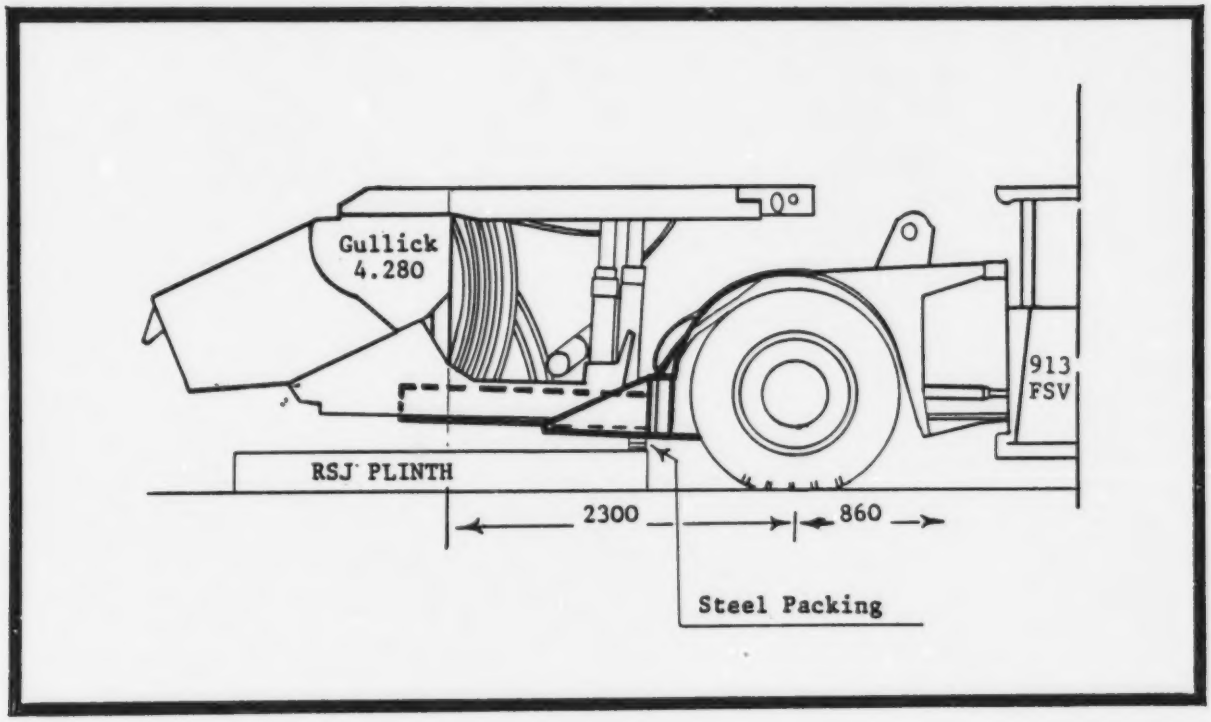
20 TONNE

HEAVY DUTY

TRANSPORTER

EIMCO 913
Support Carrier
TECHNICAL DATA

EIMCO Mining Machinery International



Specification

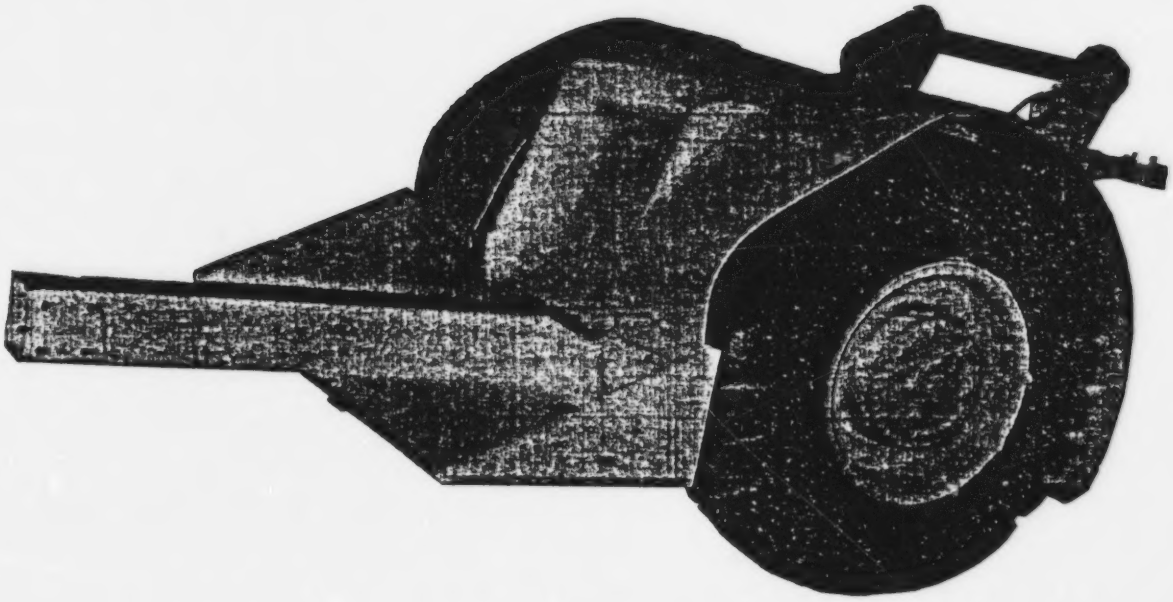
EIMCO POWERED SUPPORT CARRIER

Designed to carry specific powered supports, the EIMCO Powered Support Carrier consists of a short carrying bed with locating pins for the chock base, a probe which fits into the support ram tunnel and a special bracket for securing the chock beam. This can be fitted to an EIMCO 913 and will carry supports up to 10 tons in weight.

This unit was used to install a complete face with Gullick Dobson 4.280 powered supports each weighing 9.6t. The individual one way trip was 2500 metres with 1700 metres of this at 1 in 7 to the dip.

The Powered Support Carrier can be designed to accommodate specific types of support.

Powered Support Carrier



We reserve the right to amend, without prior notice, the information and technical data given in this specification.

EIMCO Mining Machinery International

Principal Sales Offices

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Eimco (Zambia) Ltd., Ndola, Zambia
Eimco South Africa (Pty) Ltd., Kempton Park, Transvaal
Eimco Australia Pty Ltd., Alexandria, N.S.W., Australia
Eimco Mining Machinery, Mexico
Eimco Iberica S.A., Madrid, Spain
Misui Zosen Eimco Inc., Tokyo, Japan
[illegible]econ, Vallabh Vidyanagar, Gujarat 388 120, India
[illegible]jbaumaschinen Gmbh, W. Germany

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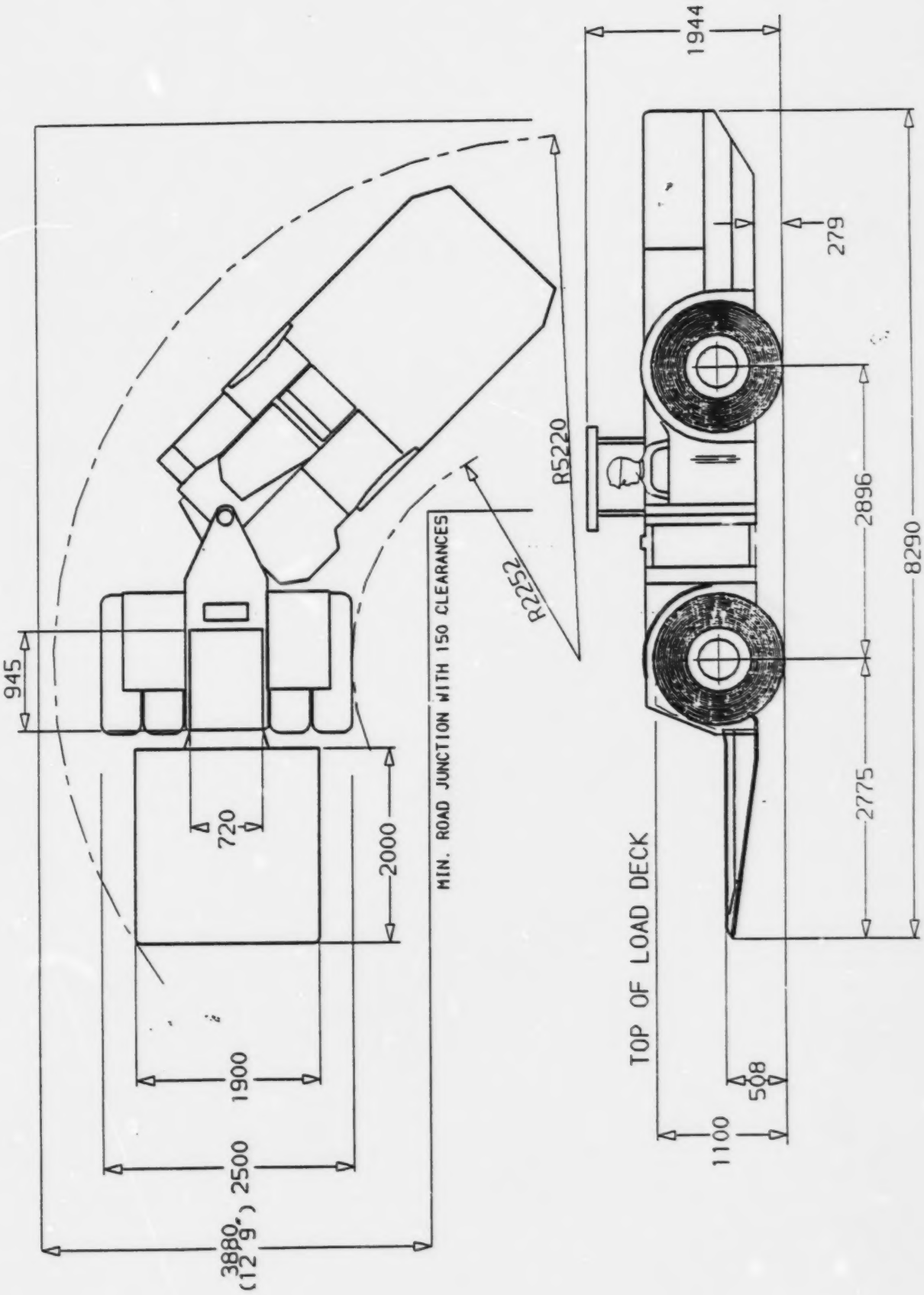

1944
279
R5220
2896
8290
R2252
945
MIN. ROAD JUNCTION WITH 150 CLEARANCES
720
2000
2775
TOP OF LOAD DECK
1900
508
1100
2500
3880
(12'9")

FEATURES

STANDARD MACHINE

The vehicle uses the existing proven EIMCO 913 format and componentry, ensuring familiarity of maintenance schedules and routines, as well as utilising the standard EIMCO 913 spare parts holding. There is also a wide choise of power packs available, ranging from 100 to 150 HP.

MINIMIUM OPERATING DIMENSIONS

The vehicle has the same overall height and length as the existing EIMCO 913. The overall width of the standard machine is only exceeded over the front wheels and it can be easily converted back to a standard machine when increased manoeuvrability is required.

LOAD CAPACITY

A simple conversion enables the EIMCO 913 to carry the heaviest loads in its class, up to 20 tonne.

PRICE AND RUNNING COSTS

With the efficient use of existing proven modules and components it is ensured that the EIMCO 913-20 tonne HEAVY DUTY TRANSPORTER has a lowest capital cost to weight carrying ratio of any machine in its class. Operating costs and parts inventory are reduced by the efficient use of existing components.

913 TRANSPORTER SPECIFICATION

POWER PACK OPTIONS

100 HP	M.W.M. type D916-6 naturally aspirated, water cooled, 4 stroke, six cylinder, in line, flameproof diesel engine.
100 HP	Caterpillar 3304 PC naturally aspirated, water cooled, 4 stroke, four cylinder, in line, flameproof diesel engine.
150 HP	M.W.M. Type D932/48 naturally aspirated, water cooled, 4 stroke, eight cylinder, V-configuration, Buxton Certified diesel engine.

POWER TRAIN

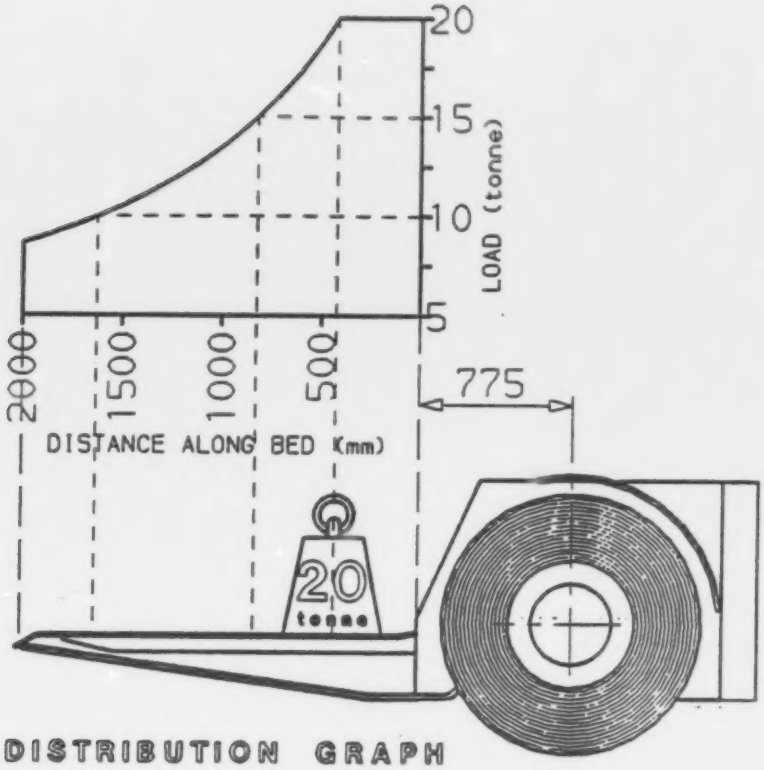
TRANSMISSION	Full powershift. 3 forward 3 reverse, heavy duty, industrial, integral torque converter.
AXLES	Clark heavy duty industrial with No Spin differential & planetry wheel ends.

BRAKES

SERVICE	Twin caliper disc brakes operating on all wheels, self adjusting, hydraulically operated.
PARKING	Transmission mounted brake, spring applied, hydraulically released for failsafe operation on all wheels.

TYRES

SIZE (REAR CHASSIS)	17.5 x 25 x 16 ply filled with TYRFIL to B.C. Specification 702.
SIZE (FRONT CHASSIS)	14.00 x 24 x 28 ply twin tyres, filled with TYRFIL to B.C. Specification 702.



LOAD DISTRIBUTION GRAPH

HAULER BED SPECIFICATION

CAPACITY	20 Tonne (44100 lbs.) in position shown.
BED LENGTH	2000 mm (79")
BED WIDTH	1900 mm (75")
OPTIONAL WINCH CAPACITY	11218 kg. (26880 lbs.)

PERFORMANCE	**20 Tonne**	**15 Tonne**	**10 Tonne**
MAXIMIUM IN LINE GRADIENT (LOAD IN POSITION SHOWN ON BED)	1 in 3.5 (28%)	1 in 3.5 (28%)	1 in 3.5 (28%)
MAXIMIUM CROSS GRADIENTS (LOAD IN POSITION SHOWN ON BED)	1 in 20 (5%)	1 in 12 (8%)	1 in 8 (12.5%)
MAXIMIUM SPEED UNLADEN ON LEVEL	17 km/hr (11 mph)		

HYDRAULIC SYSTEM

PUMP TYPE	Gear.
OUTPUT	136 L/min (30 gpm)
SYSTEM PRESSURE	138 bar (2000 psi)
FILTRATION	Rating, 12 micron absolute.
FILTER [ELEMENT]	Disposable.
CYLINDERS	Extra heavy duty with self aligning end bearings

TANK CAPACITIES

HYDRAULIC	297 Litre (65 gals.)

STEERING

TYPE	Centre articulated, full power hydraulic with accumulator reserve. Stick operated.
SYSTEM PRESSURE	138 bar (2000 psi)
ARTICULATION JOINT	Heavy Duty self-aligning hardened steel bushing

ELECTRICAL SYSTEM

TYPE	24 volt FLAMEPROOF

STANDARD EQUIPMENT Head/tail lights, 2 front, 2 rear.

SEATING

TYPE	On left side of rear frame, cross seating with bi-directional visibility.

APPENDIX D

CONDITIONS GOVERNING THE USE OF SINGLE ENTRY SYSTEMS AT RHEINLAND MINE
(Translation)

TRANSLATION

From: LANDESOBERBERGAMT NORDRHEIN-WESTFALEN
Postfach
4600 Dortmund 1

21st May 1985
r 17 - 2.11 - 8 - 6

To: Bergbau AG Niederrhein
Postfach 17 02 60
4100 Duisburg 17

Your Ref.: WD 40/Dr.B./St./Bl.
40/0178/85 dated 29.01.85

Re.: Werksdirektion Rheinland;
Extraction of Residual Coal from Short Faces
Application for the Grant of an Exemption
from the Regulations of § 145 Abs. 2 BVOSt

Approval of the Plan of Working:

On the basis of § 344 Abs. 1 of the Bergverordnung des Landesoberbergamts Nordrhein-Westfalen für die Steinkohlenbergwerke (BVOSt - mining regulations of the superior board of mines of Nordrhein-Westfalen for the hard coal mines) dated 20.02.1970 the superior board of mines herewith grants to the link-up mine Rheinland the following exemption from the regulations of § 145 Abs. 2 BVOSt following the application dated 29.01.1985 with the enclosed documents and the discussion on the 09.05.1985:

The shortwall mine working on either side of the base roadway in the Hermann-Gustav seam at the staple pit (HO) 06 may be carried out on a trial basis and with special ventilation in the pillars having a maximum width of 33 m.

1. According to the application documents, in particular the expertise of the test station for mine ventilation No. 12303684 dated 25.07.1984, the following is postulated:

1.1 The working area can be considered as being free from methane within the measuring precision of the monitoring devices.

1.2 If unexpected gas emission occurs which exceeds 2 m³ CH_4/min. in total mining must be stopped immediately and finally.

2. The following provisions must be adhered to:

2.1 The angular flexibility and tightness of the ventilating channel must be proved to and certified by the test station for mine ventilation by means of prototypes in a permanently ventilated working area on the basis of the testing standards for airducts.

Corresponding evidence with a certificate of the test station for mine ventilation and of the main station for mine rescueing must also be provided for the other features of the ventilating channel (tightness and security against fracture also in the transition area face/roadway, safety operation of the access and by-pass openings as well as the air distributor at the blow-out end of the ventilating channel) and this in consideration of ventilation, escape and rescue aspects (compare also item 2.2).

The grant of exemption will only become effective when the superior board of mines receives these evidence certificates.

2.2 In the especially ventilated working area the mining operations must only commence after the test station for mine ventilation and the main station for mine rescueing have proved by means of acceptance tests that the following regulations are complied with:

2.2.1 The condition of ventilation, and in particular of the ventilating channel, as well as the operation of the access and by-pass openings of the ventilating channel with the possible adjustments must not lead to critical ventilating conditions. The access and by-pass openings must be secured against unauthorized operation (e.g. by lead). Telephone communication must be available between the access openings on the face and the fan area.

2.2.2 An air current of 7 m^3/s must be maintained in the cross-section of the face over the full length of the face. In order to avoid CH_4 accumulations sufficient air current speeds must be ensured in all areas. These requirements are applicable to all operating conditions (e.g. electric or compressed air drive of the combi-fan).

2.2.3 The minimum air speed of 0,5 m/s must be maintained in the base roadway, also at the side of the special ventilating airduct.

2.2.4 The arrangement and functioning of the flow and gas measuring monitoring devices must ensure that the electrical equipment on the face and in the base roadway on the return air side are automatically and instantaneously switched off when the switch-off limit values for the mininum air current (compare item 2.2.2) and for the CH_4 content (compare item 2.3) are reached and that at the same time acoustic and optical signals are given at a permanently attended station.
CH_4 switching-off must be effected directly by the measuring device (not only by the process control computer).

In particular, the measures must be determined by which continuously perfect monitoring at the measuring point 8 (Annex 8 of the application) is ensured.

2.2.5 The stationary CH_4 measuring devices must also give acoustic and optical warning signals at the permanently attended station when the warning limit values are reached.

2.2.6 The measured values of the measuring devices must be remotely transmitted to and recorded in the permanently attended station.

2.3 The CH_4 limit value must be treated as follows:

2.3.1 If 0,1 % CH_4 are reached at a measuring point controls for CH_4 accumulations must be carried out during every shift by especially assigned supervisors or air-flow measuring crews or firemen according to the detailed instructions of the ventilation engineer (particularly on the face and near the fan of the special ventilation).

2.3.2 In ventilating currents up to 11 m^3/s automatic switching off (item 2.2.4) of the electrical equipment must be ensured when 0,3 % CH_4 are reached, in ventilating currents up to 17 m^3/s when 0,2 % CH_4 are reached. Ventilating currents exceeding 17 m^3/s must not occur in the special ventilation area.

2.3.3 After switching off according to 2.3.2 mining must only recommence after the fireman has ascertained that the CH_4 limit value according to 2.3.2 is no longer reached and that the limit value of gas emission according to 1.2 has not been exceeded. For assessing whether the limit value has been exceeded according to 1.2 it might be necessary to consult the test station for mine ventilation.

2.4 Prior to switching the electrical equipment on again after it has been switched off automatically (2.2.4) regular ventilation must be ensured and it must be ensured by manual CH_4 measurements that the CH_4 switch-off value is nowhere reached.

2.5 The safety prerequisites for the use of the ventilating channel for escape and rescue reasons must be stipulated in cooperation with the main station for mine rescueing in a plan to be approved by the board of mines in a working plan procedure. The stay of persons on the face is only admissible if the communication between the face and the fan area is ensured by a person who is staying near the fan. The persons staying on the face must be instructed and trained for the use of the ventilating channel as an escape way and they must have eye protectors. Training is also required for the use of a rescue basket. At least one suitable rescue basket (sliding shoe or roller mounted, if necessary) with the required pulling ropes must be available; a man-riding rope must be provided in the ventilating channel.

2.6 The regulations of the special ventilation rules applying to the methodical arrangement of the special ventilation equipment and its monitoring must be complied with. Service instructions must be given to the persons in charge for the execution of the shifting operations as the face advances, for the operation of the access and by-pass openings and for the measures to be taken in the case of a failure of and for re-starting the special ventilation equipment.

2.7 The persons charged with safety tasks at the permanently attended station must be qualified for these tasks with regard to their aptitude, training and reliability; they must be given service instructions.

2.8 The permanent respect of the safety concerns of the trial site must be ensured by particularly intensive supervision by responsible personnel. From time to time the test station for mine ventilation must carry out tests, evaluate the measured data, and issue quarterly a summarizing report.

2.9 Two copies of the report with the test results, evaluations and judgements must be immediately submitted to the board of mines.

2.10 The roof supports in the base roadway must be back filled with setting building materials.

2.11 The powered supports must be set as close as possible to the roadway dam; any delays in setting the supports must be avoided.

2.12 The final shield at the blow-out end of the ventilating channel must be equipped with special protection devices against falling rock and coal for the protection of persons and for securing the blow-out end of the ventilating channel.

2.13 It must be ensured that a sufficient clearance is maintained between the lowered roof supports and the ventilating channel.

2.14 On the face side the travelling track must be arranged in front of the row of roof support legs.

2.15 Further details can be determined by the board of mines in the working plan procedure in accordance with the requirements and in cooperation with the special branches.

Notes:

In our decision of the 12.04.1984 - r 17 - 2.11-7-24 - you have already been made aware of the risk of the stoppage of the operations. As a precaution your attention is again drawn to the fact that, according to the experience made, mining operations under special ventilation conditions and with a methane emission above the measured value of 2 m^3/min. are not justifiable from a safety point of view and will not be permitted in future. Moreover, compliance with § 130 AAbs. 1 BVOSt must be ensured.

This grant of exemption can be revoked; it is valid until the 31st March, 1987.

Instead of the administration fee which is due in accordance with the tariff scale, item 3.3.6, of the general administration fee scale of Nordrhein-Westfalen of the 09.01.1973 a lump sum has been paid.

An objection against this decision can be raised within one months after the notification. The objection must be submitted in writing to the superior board of mines NW in Dortmund, Goebenstr. 25. Should this period expire due the fault of a person authorized by you, his fault will be conferred upon you.

One copy of the application with its annexes is enclosed.

- Signatures - STAMP: Landesoberbergbamt
Nordrhein-Westfalen

TRANSLATION

From: BERGBAU AG NIEDERRHEIN
Postfach 17 02 60
4100 Duisburg 17

29.01.85
Ref.: WD 40/Dr.B./St./Bl.
40/0178/85

To: Landesoberbergamt NW
4600 Dortmund

dlfd. Bergamt Moers
Ostring 1
4130 Moers 1

Werksdirektion Rheinland

Pattberg-Rossenray Mine

2. Application for the Grant of an Exemption from the Regulations of § 145 Abs. 1 and 2, BVOSt

Plan of working:

The Bergbau AG Niederrhein pursues the project:

Extraction of Residual Coal by Shortwall Technology

under the Innovation Program III of BMWi.

The aims of the project are:

- The extraction of areas left unmined due to the layout and, hence, a considerable improvement in the utilization of the deposit.
- A reduction of the remaining areas with the resultant positive influence on rock mechanics and possibly a reduction of internal and external subsidence damage.

Due to the development of the mining technique towards large scale mining operations with high investment costs the mining panel is laid out for troublefree operation. This layout planning therefore leaves remaining areas which cannot be mined economically according to the conventional longwall mining method. The utilization of the deposit is therefore reduced and is at present in the range of 60 % with the undesired accompaniments both economically and with regard to rock mechanics.

We feel that the introduction of a suitable shortwall technique will allow for the extraction of part of these remaining areas without the need for driving additional roadways.

The Hermann-Gustav seam (see Annex 4 and 4a) has been chosen as a site for the trials using the shortwall technique. First of all, the possibilities of a general limitation with regard to the minimum seam thickness and the length of the shortwall faces shall be examined.
In this respect we are quite aware that the length of a shortwall face will be generally limited.

As the application of such a technique involves some paragraphs of BVOSt we herewith apply for the grant of an exemption from these regulations.

1.0 Grant of Exemption from § 145 Abs. 1 BVOSt

According to § 145 Abs. 1 a second travelling and ventilating road is required for each panel.

Abs. 1 Independent of the ventilating roads in the working area each panel must have a second travelling and ventilating road from the intake level to the return level.

At the same time the protection required in § 118 Abs. 5 BVOSt must be ensured.

Abs. 5 It must be possible to reach the surface on two separate ways from each interconnected working area.

Shortwall operation can meet these requirements if substitute measures are taken. In our opinion the use of the proposed ventilating channel, the design of which will be explained in the following, offers the protection required in the above paragraphs.

1.1 Roof Supports / Ventilating Channel

The roof supports to be used are 2-leg Klöckner-Becorit shields with an integral ventilating channel (see Annex 1, a and b).

It should be noted that contrary to the original intention the ventilating channel is arranged within the protected area inside of the roof supports.

We shall have four prototypes manufactured and install them in an existing working in order to prove their suitability for the planned shortwall face. Particular attention is paid to the connection of the individual elements of the ventilating channel as well as to its angular flexibility and tightness.

The testing station for mine ventilation will be called in for an assesment.

The requirements of the authorities which are to be met by the hydraulic roof supports are the basis of the design. Proof will be provided by the usual tests for new designs carried out by the material testing authorities (Materialprüfungsamt - MPA) and the Steinkohlenbergbauverein (StBV). The design of the sliding roof bar used ensures that it can be retrofitted with coal face sprags, if required.

The last roof support unit in the depth of the shortwall face will be provided with a lateral safety device to prevent coal or adjacent strata to break in or flow in.

The face entry will be secured by roof bolts or by the use of sliding roof bars or other suitable roof support elements (Annex 2, a, b, c).

1.2 Protection § 118 Abs. 5 BVOSt

The ventilating channel may serve as an escape way in the case of an emergency. It will be provided by us with access and exit openings in accordance with the comment given by the mine rescue station (see Annex 3). The face end area will be laid out for stability, so that a complete obstruction of the access can be considered as impossible.

Should rescueing become necessary the fan will be changed over to its compressed air section and will therefore allow for travelling in the ventilating channel. Changing over is carried out both locally and by remote control. Unlocking of the access and exit opening at the face end is possible on both sides.

We shall inform you as soon as definite details of the ventilating channel in the area of the face entry, including the by-pass solution, are known.

1.3 Grant of Exemption from § 145 Abs. 2 BVOSt

Ventilation and Ventilation Monitoring

The trial site will be located in an area to the West of the Bornheim fault in which the Hermann-Gustav seam can be considered as being free of methane (Annex 4 and 4 a). CH_4 has not been found, neither in the

underlying workings - BH 347 - already mined in the Anna seam nor in the underlying workings - BH 348. This also applies to the part of the panel with the workings BH 350 and 351 to the North of the disturbed area. This is evidenced by the ventilation reports (Annex 5). It is also confirmed by the enclosed expertise of the test station for mine ventilation dated 24.7.1984 on the gas emission to be expected when mining the shortwall face (Pfg.-Nr. 12 303 686) (Annex 6).

With regard to ventilation and monitoring of the shortwall face we shall adhere to the recommendation of the expertise of the above authority dated 26.7.1983 (Pfg.-Nr. 14 104 483) (Annex 7).

The direction of advance of the trial face will be chosen so that the fresh air current passes through the part of the permanently ventilated roadway in which mining has already taken place.

The direction of advance and the direction of ventilation are therefore equidirectional. This means that the ventilation fan is operated in the part of the roadway already mined. This ensures that a pressure drop of the ventilation current occurs in the direction of the face and any creeping ventilation currents through the gob are kept at a minimum. Moreover, the face border will be sealed and stabilized by a solid dam.

The air current fed to the special ventilation fan amounts to at least 1,3 times the fan air current. The minimum air speed of 0,5 m/s will be maintained, also at the side of the airduct. We shall install a combi-fan with an electrical nominal power of at least 24 kW. According to the calculations of the test station for mine ventilation it is expected that the fan air current amounts approx. 10 m^3/s if the ventilation channel is tight. In the case of leakage the fan will be displaced towards the larger ventilating current.

The ventilating current at the end of the ventilating channel depends on the tightness of the channel. However, we expect that a ventilating current of at least 8,3 m^3 to 9 m^3 will be availa le at the blind end of the face. The characteristic of the proposed fan shows that only a slight reduction of the air volume will occur if the compressed air section is operated with four nozzles. However, should it become necessary for complying with the regulations to provide a higher air volume for the

face we shall install a fan with a correspondingly higher nominal rating. The operating of the ventilator will be displayed at a permanently attended station.

The discharge end of the ventilating channel will be designed as proposed by the test station for mine ventilation, so that high air speeds and a high dynamic pressure which would press a partial air current into the caving area are avoided at the discharge end.

The test station for mine ventilation will be consulted in order to solve any ventilation problems.

Compliance with the recommendations of the test station for mine ventilation will be ensured.

The air current will be monitoring in the permanently ventilated area, in the ventilating channel, and in the travelling track of the face near the roadway. The limit values of the individual air speed measuring devices will be agreed upon with the test station for mine ventilation. We intend to install a microcomputer for detecting and processing the values measured and it will also serve for evaluating the data and for sending any warning and trouble signals to the permanently attended station.

The measuring arrangement for monitoring the CH_4 content of the ventilating current will also be determined according to the recommendations of the test station for mine ventilation. Moreover, we shall also monitor to total return air current of the site. Also the CH_4 measuring devices send their data via the proposed microcomputer to the permanently attended station, so that the air currents and the detected CH_4 content of the air are automatically correlated.

With regard to the warning and switch-off values the recommendations of the test station for mine ventilation will also be taken into account and we propose that a warning be given when 0,1 % CH_4 are reached and this will lead to a check of the specially ventilated part of the working for any CH_4 emission. The non-intrinsically safe electrical operating means in the specially ventilated part of the working will be arranged for being switched off when 0,3 % CH_4 are reached. We shall charge the test station for mine ventilation with the evaluation of the measured data obtained and with the expert supervision of the working (see Annex 8).

2.0 General Information on the Trial Face

As shown on the plan view the planned trial face (see Annex 4 and 4 a) will be tied to a base roadway which is dammed up at present and it will be independent of other workings. This working will be treated as a separate ventilation section (see Annex 9a and 9b).

2.1 Working Order (Annex 4 a)

The planned working direction of the shortwall face is from Northeast to Southwest. At first the part to the West of the base roadway will be mined, and then the part to the East. When the shortwall face approaches the KA roadway of BH 347, crossing the base roadway, there are two possibilities:

a) Mining ending North of the roadway and re-starting South of it after the move.

b) In the second case a method already successfully applied at WD Rheinland could be used: clearing-out, removal of the roof supports and subsequent stowing with a suitable material.

2.2 Base Roadway

The centre roadway already mentioned is supported by conventional, rigid B 15,6 arches. Taking the pressure and convergency calculations as a basis, it must be assumed that the roadway will not meet the requirements (see Annex 10) - Investigation Report No. 3590 of the Bergbau-Forschungs-GmbH. We shall adapt the centre roadway to the required conditions by suitable measures, e.g. enlargement. The roof supports, bolts and lining are non-combustible. Back filling will be done, if required.

2.3 Danger of Rock Bursts

In the above part of the panel there are no signs for a danger due to rock burst and this has been checked in accordance with the "Check list for the examination of workings for a possible danger of rock bursts".

2.4 Escape Way

The escape way leads, corresponding to the direction of ventilation, to the Southeast to the level of the Anna seam. It will take 15 minutes before the fresh air area is reached. The further escape way to the staple pit (HO) 06 will take 12 minutes. This stable pit is equipped with a man-riding facility (see Annex 11).

2.5 § 140 BVOSt, Abs. 3

The length of the caved area along the caving line must not be less than 30 m. The length of the shortwall face ranges from 32,oo m to max. 33,oo m. This therefore complies with § 140 BVOSt Abs. 3.

As already mentioned the face border will be secured by a solid dam and, according to the recommendations of the StBV, this has a width of 0,35 ·mfl (2,0 m) = 0,7 m (see Dr. Goetze/Krahe, StBV). The maximum distance to the coal face corresponds to the length of the sliding roof bars + 1,60 m (Annex 2).

§ 140 BVOSt, Abs. 4

If the caving area is not properly filled at a distance of 3,00 m behind the caving line, the responsible supervisor must give instructions for the reinforcement of the face supports. If the caving area is not properly filled at a distance of 6,00 m behind the caving line, coal winning must be stopped until safe conditions are re-established.
For complying with paragraph 4 the nature of the adjacent strata in the roof of the planned working site should be mentioned. This is a mild argillaceous slate and a thin sandstone plate (see Annex 4 a).
The experience has shown that the roof of the Hermann-Gustav seam caves in fine pieces at the caving line. Moreover, the roof supports will be provided with lockable control openings on the side of the caving area to allow for shotfiring.

2.6 Operating Means Used

For coal winning and handling an ESA-150 (see Annex 12) of Messrs. Eickhoff and an EKF II conveyor will be installed. The winning machine

and the conveyor are electrically operated. These machines consist of proven and approved components. They are modified for this first installation. In line with the state of the art we endeavour to control the mining equipment by a radio remote control system.

2.7 Planned Output

At the present stage it is premature to state figures for the first installation using this technique. If 12 to 15 MS/shift are employed in this working an output of 350 t/shift (saleable) must be reached to compare with other workings. This would correspond to a face advance of va = 5,00 m/shift.

2.8 Dust and Fire Suppression

Dust suppression will be ensured by coal face infusion, water spraying at the transfer points, water sprays on the drum of the shearer as well as on the roof bars of the roof supports. Due to the use of approved machines and components, operation of the ESA-150 with the fire-resistant hydraulic fluid HFC 46 and on account of the nature of the coal we do not think that there is a fire hazard.

For fire fighting the spray water of the winning machine can be used. If other operationally safe methods can be installed in accordance with the latest state of the art, e.g. direct water supply to the cutting tools, these will be included in the project.

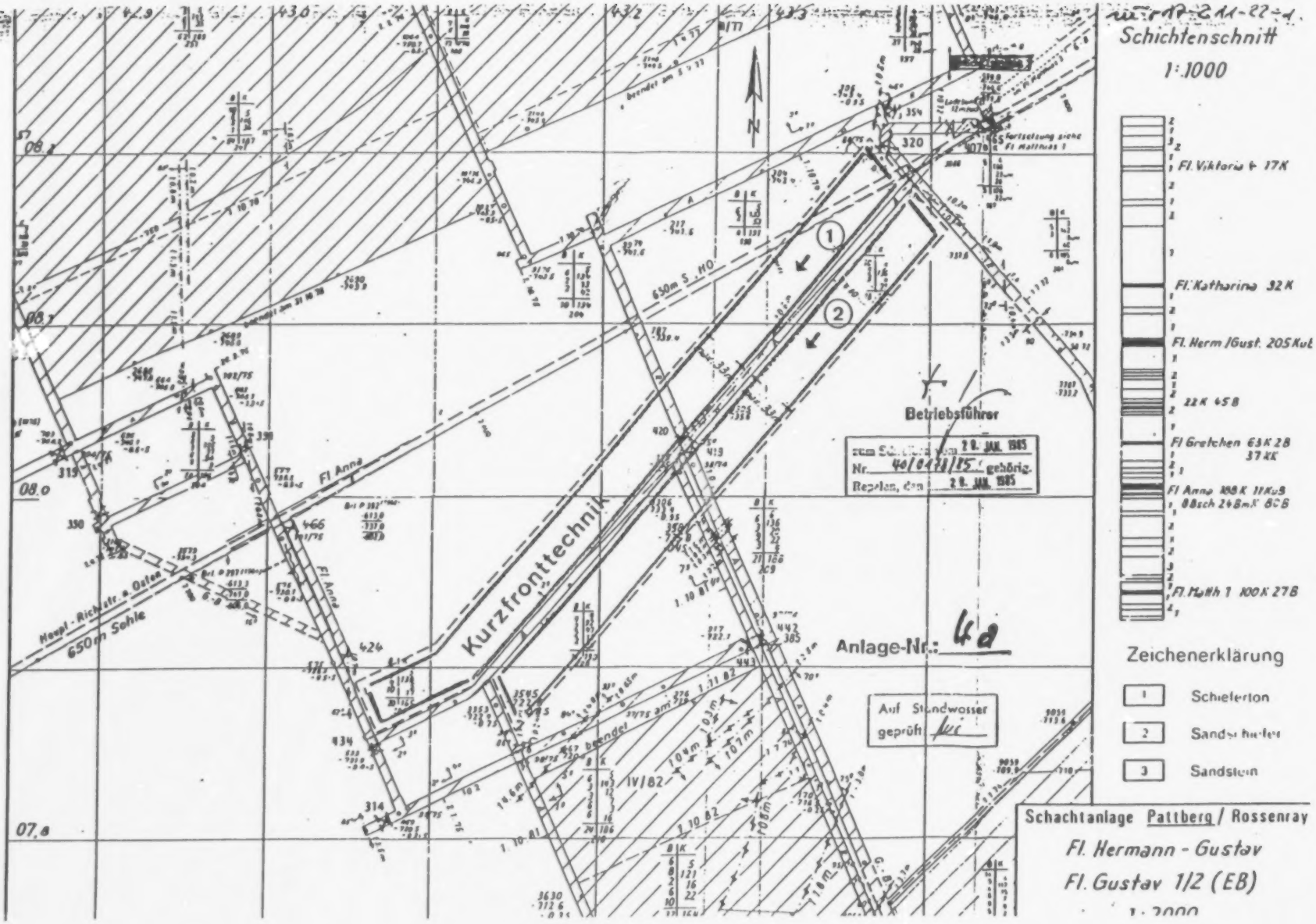
The working area in question will be secured by explosion barriers of the type 4.

Your approval of the project would be appreciated.

The workers' council has been informed and did not raise any objections.

Bergbau AG Niederrhein

- Signatures - Stamp: Bergamt Moers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1 Schieferton
2 Sandschiefer
3 Sandstein
Kurzfronttechnik
Fl. Anna
650m Sohle
Betriebsführer
Anlage-Nr.: 4a
Auf Standwasser geprüft
Schachtanlage Pattberg / Rossenray
Fl. Hermann - Gustav
Fl. Gustav 1/2 (EB)
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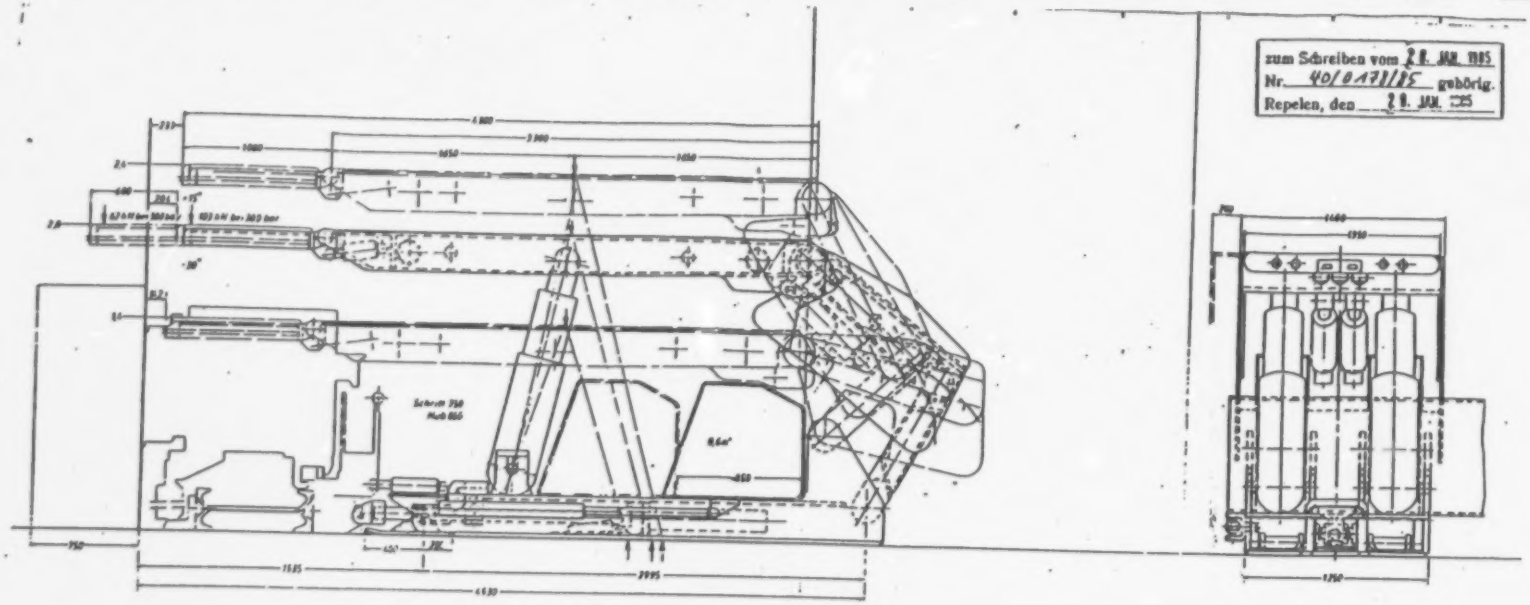
zum Schreiben vom 28. JAN. 1985
Nr. 40/0173/85 gehörig.
Repelen, den 28. JAN. 1985



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Geprüft
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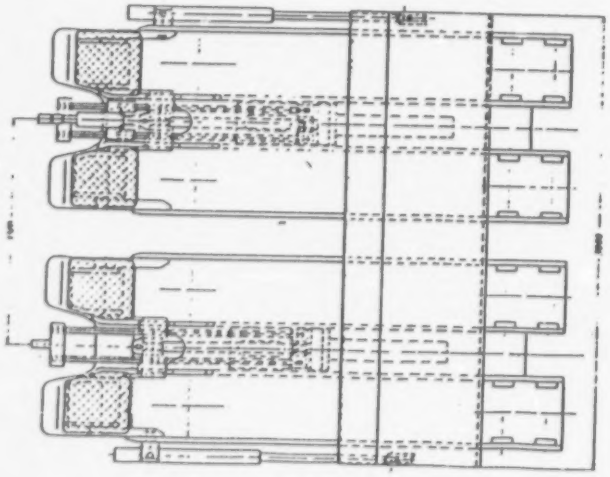
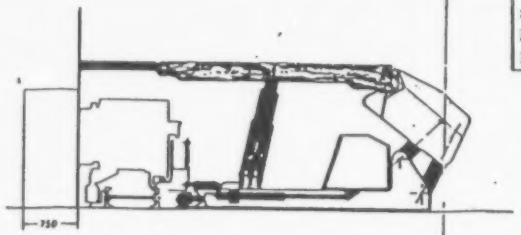
Bergamt Moers
i. A.



Betriebsführer

Anlage-Nr.: 1

zum Schreiben vom 20. JAN. 1985
Nr. 40/0178/85 gehörig.
Repelen, den 20. JAN. 1985



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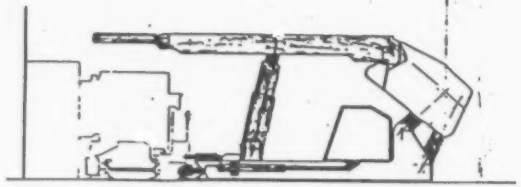

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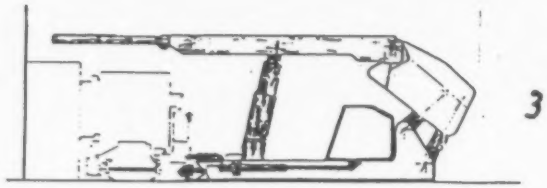
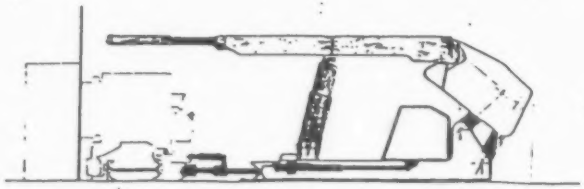


3 Schiebekappe ausgefahren



4 Förderer gerückt
Gewinnungsmaschine eingeschnitten

Betriebsführer

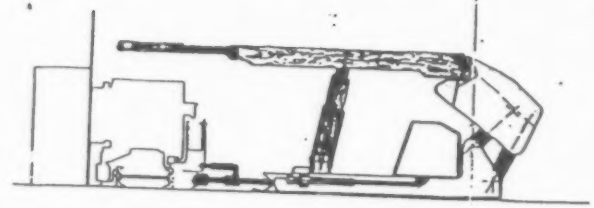
Anlage-Nr.: 1a

1.17-2 4-22-12
Geprüft
Moers, den 25.03.85
Bergamt Moers

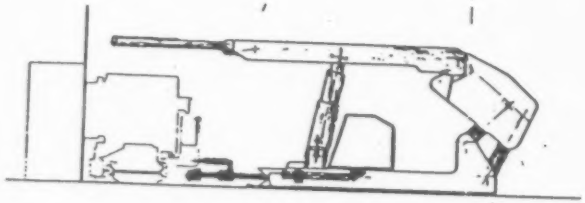
Bergamt Moers

zum Schreiben vom 28. JAN. 1985
Nr. 40/0471/85 gehörig.
Repelen, den 28. JAN. 1985

Anlage-Nr.: 1b



4 Förderer gerückt
Gewinnungsmaschine
eingeschnitten



5 Wetterkanal
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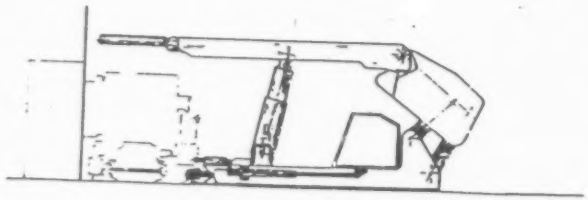
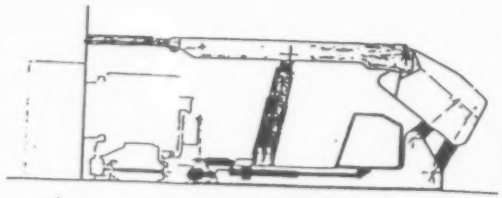


6 Ausbau nachgezogen



7 Ausgangsstellung

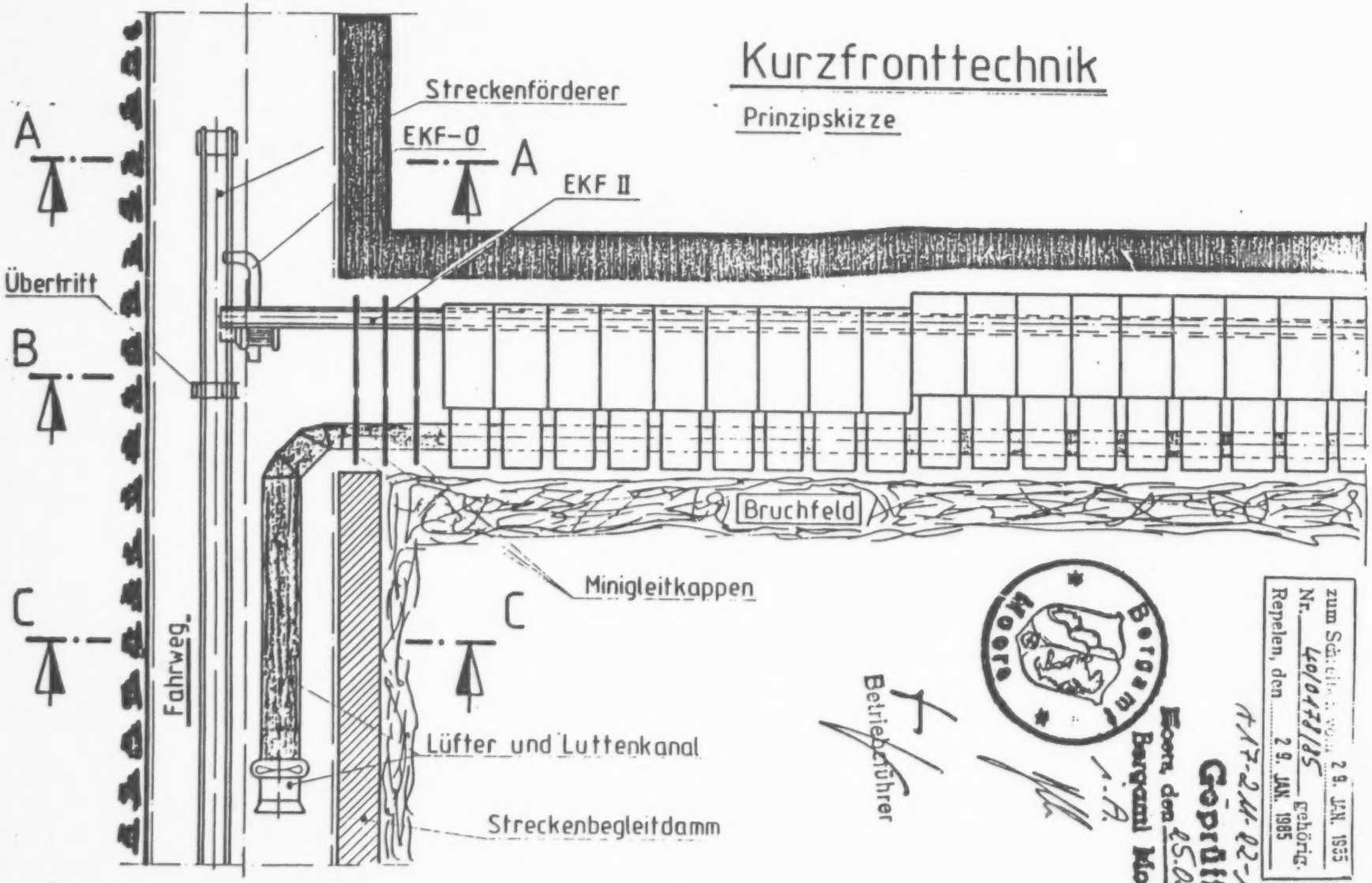
Betriebsführer

A17-2.11-22-R
Geprüft
Moers, den 25.03.85
Bergamt Moers
i.A.

Bergamt Moers

Kurzfronttechnik

Prinzipskizze



Anlage-Nr.: 6

zum Schreiben vom 29. JAN. 1985
Nr. 40/0178/85 gehörig.
Repelen, den 29. JAN. 1985

A17-2M-82-12

Geprüft
Moers, den 25.03.85
Bergamt Moers
i.A.

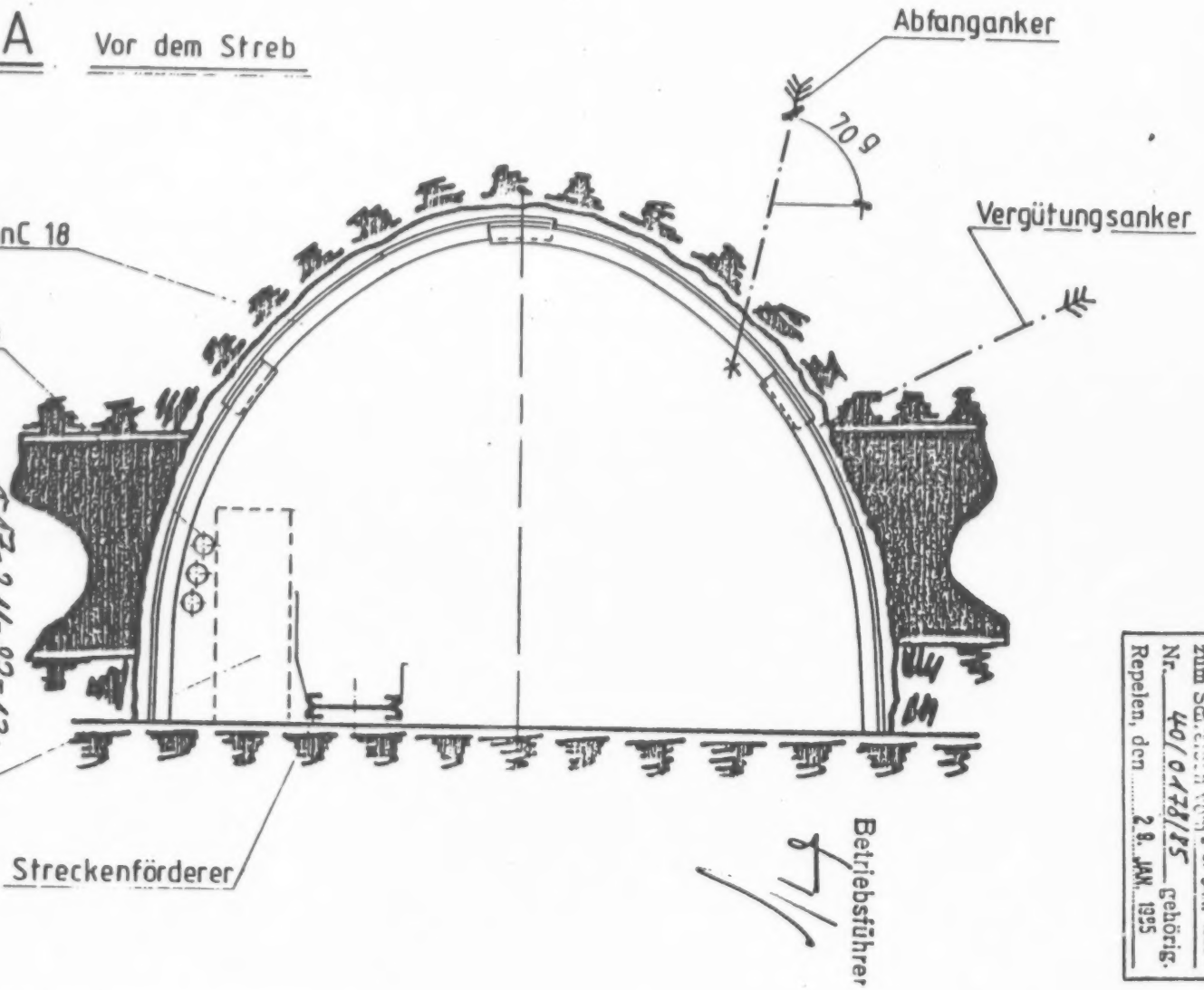
Betriebsführer

Bergamt Moers

Schnitt A-A

Vor dem Streb

Prinzipskizze



Bergamt Moers

Geprüft
Moers, den 25.03.85
bergamt Moers
i.A.

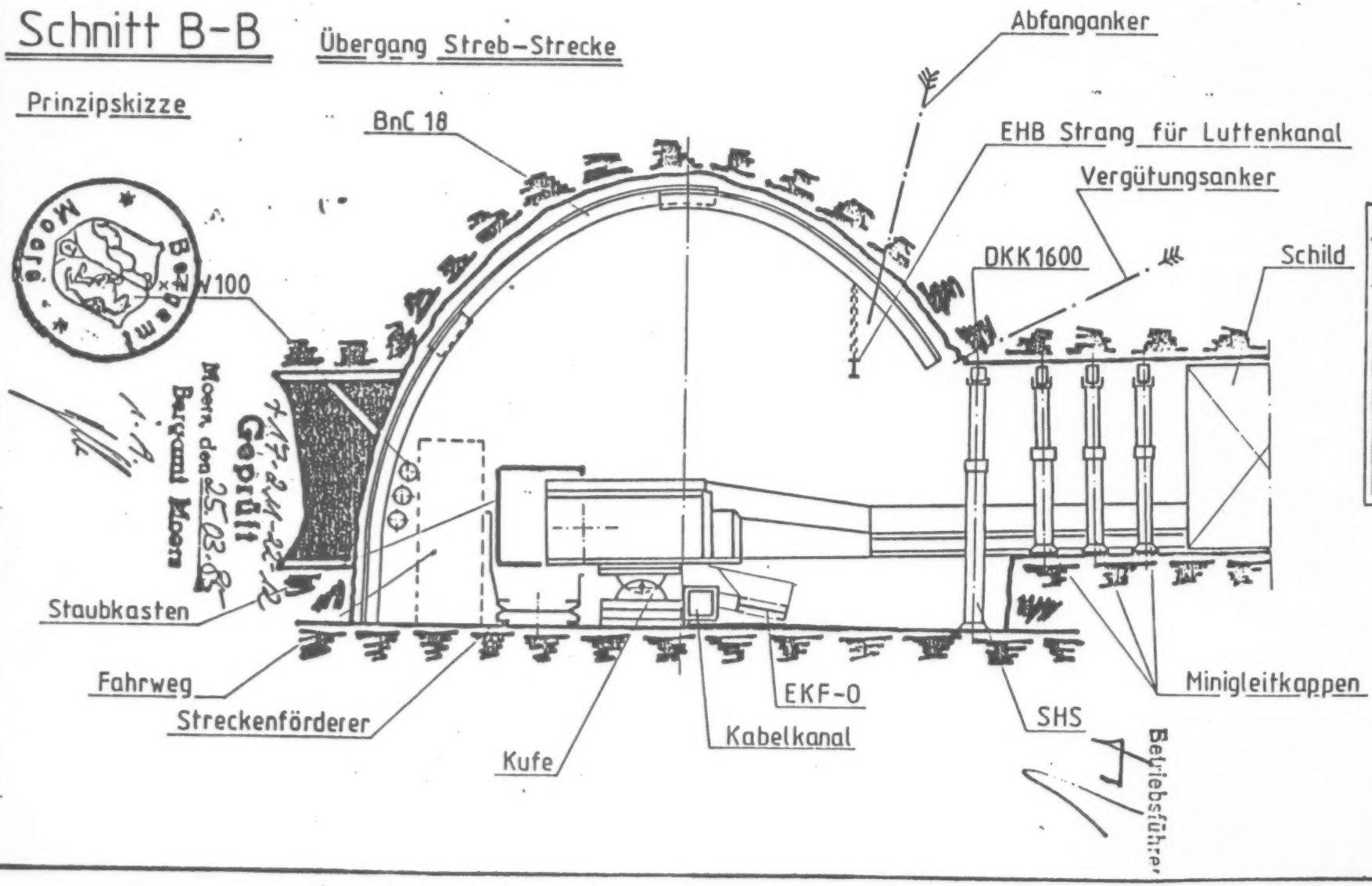
Anlage-Nr.: 2

zum Schreiben vom 29. JAN. 1985
Nr. 40/0178/85 gehörig.
Repelen, den 29. JAN. 1985

Schnitt B-B

Übergang Streb-Strecke

Prinzipskizze



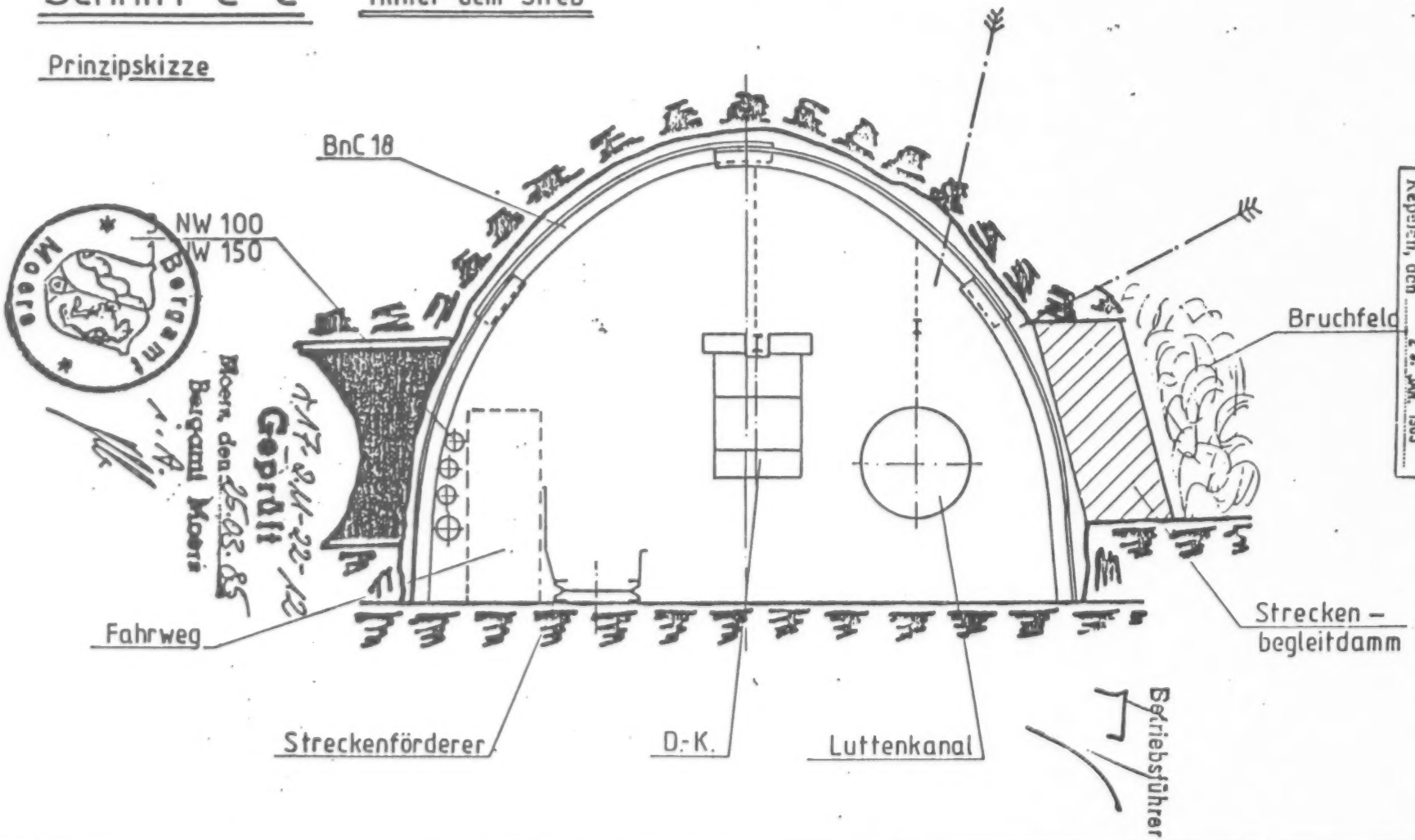
zum Schreiben vom 29. JAN. 1985
Nr. 40/047H/15 gehörig.
Repelen, den 29. JAN. 1985

Anlage-Nr.: 26

Schnitt C-C

Hinter dem Streb

Prinzipskizze



zum Schreiben vom 29. JAN. 1985
Nr. 40/017/125 gehörig.
Repelen, den 29. JAN. 1985

Anlage-Nr.: 6 C

Bergamt Moers

Geprüft
Moers, den 25.03.85
Bergamt Moers
i.A.

17-2M-22-12

APPENDIX E

MINE VISITS REPORT

APPENDIX E

SUMMARY REPORT ON VISITS TO MINES AND MANUFACTURERS IN CANADA, ENGLAND AND WEST GERMANY

09 November to 24 November 1987

4 December 1987

1.0 GENERAL

In accordance with the method of work proposed for this study, a series of mine visits and discussions were undertaken in Canada, England and West Germany in order to obtain information from mines on the operation of single entry faces and from equipment manufacturer's on the equipment used in heading drivages and on single entry faces.

The program undertaken is given in Table 1. The visits to Nova Scotia (9-13 Nov.) were undertaken by Messrs. Muirhead (Monenco), McGowan (Obed Coal) and Moss (Golder Assoc.), whilst the visits to England and West Germany were carried out by Messrs. Muirhead and McGowan.

A brief summary of each visit is given in the following sections.

2.0 CANADIAN VISITS

2.1 CANMET COAL RESEARCH LABORATORY

Meetings were held with (1) Mr. G. Haslett, Scientific Authority, concerning the program for the study and to receive a briefing on the CBDC mines and operations; and (2) Mr. T. Aston Research Scientist, concerning mine subsidence predictions, support design, and rock bolting.

2.2 LABOUR CANADA

A meeting was held in CANMET's offices with Mr. T. Smales, Senior Mine Safety Engineer (Atlantic Region), Mr. L. Hicks, Mine Safety Engineer, and Mr. G. Haslett to discuss the possible application of the Single Entry Short Longwall Retreating (SESLR) system into the Cape Breton Development Corporation's (CBDC) mines.

The following major concerns were identified, which would have to be addressed in the study.

- Adequate ventilation
- Adequate monitoring and control
- Safe support with particular attention to face/roadhead area
- Manpower limits

- Managers safety scheme
- Dust control
- Training

Comment was also made that Prince Mine would probably be the best place to start the system due to lower gas makes and gradients than the Lingan and Phalen mines.

2.3 CAPE BRETON DEVELOPMENT CORPORATION (CBDC)

A meeting was held at the Corporation's head office in Glace Bay with Mr. R. Cooper, Vice President Operations, Mr. R. MacLean, Vice President Engineering, and Mr. G. Haslett, Canmet.

The operations at CBDC's three undersea coal mines--Prince, Lingan and Phalen--were first outlined, followed by discussions on the single entry short longwall retreating system and on potential applications and sites in the three mines.

In the Prince Mine, the possible candidates identified were:

(1) the area between the shoreline and 1W retreat face to the -180' cover line; and

(2) the area between the shoreline and 1E retreat face, limited to the East by the high ash content of the coal.

In the Lingan Mine, the possible candidates were:

(1) the area between 1W face and the southern barrier pillar to #20 Mine workings;

(2) the area to the south of the room and pillar workings and east of the main slopes; and

(3) the pillars off the main slopes left between successive longwall faces.

At the newly opened Phalen mine, potential areas were:

(1) the triangular area between the main Deeps and the Main Slopes; and

(2) the areas between the existing 1E and 1W faces and the barrier pillars to the old workings in #26 and Lingan collieries.

A program of visits to the Prince, Lingan and Phalen Mines was also scheduled.

2.4 PRINCE MINE, PT. ACONI

The visit to Prince mine on 10 November incorporated underground visits to 6W Retreating face and 7W Headings, and discussions with mine officials.

R. MacIntyre	Mine Manager
F. Howard	Operations Manager
S. Fuginski	Engineering Services Manager
B. Mackenzie	Geologist

Prince Mine is an undersea mine working the Hub Seam. Early mining in 1976-1977 was by room and pillar methods under the Pt. Aconi peninsula. This was not successful, primarily due to extremely soft floor conditions. The mine access slopes were extended under the sea and, beyond the 550 ft. cover contour, short retreating longwall faces were established commencing production in May 1980. These were successful and the method has been continued.

The mine is designed to produce 25,000 t/week from a single retreating longwall face and several development headings for extension of the main slopes and for new faces.

The mine operates 15 8-hour shifts per week and employs 670 men. The Hub Seam averages 2.3 m in thickness, but varies from 1.8 m to 2.45 m according to the presence or otherwise of a rider seam, generally being thicker in the eastern part of the take.

Summary details of the methods and equipment used on 6W face and 7W headings are given in Tables 2 and 3 respectively.

General comments include:

1. Sandstone washouts and/or rolls cause problems;

2. Immediate floor in present working area is hard mudstone;

3. Immediate roof of shale/mudstone/siltstone (5m) with sandstone above;

4. Main deeps driven by Dosco Mk 2A and 2B roadheaders; and

5. Dosco In-Seam Miner, Westfalia VME and Anderson Boom Miner being evaluated for Face Development (30 m/day potential).

6. Maintenance on 'as required' basis with repairs scheduled for weekend.

7. Maximum length of roadway driven on auxiliary ventilation is 900-1000 m.

In area between retreat faces and the 55 m cover line, there is estimated to be some 20 Mt of coal which could be recovered by some form of partial extraction. This is the prime target area for the single entry longwall system.

2.5 LINGAN MINE, NEW WATERFORD

The visit to the Lingan Mine on 12 November incorporated underground visits to 10E and 7W longwall advancing faces and discussions with mine officials.

P. Jones	General Manager
A. Harvey	Mine Engineer

The Lingan Mine was designed to produce approximately 1.45 Mt clean coal per year.

The access slopes to the mine commenced in 1971 and by early 1972, coal was being produced from room and pillar workings in the area to the east of the main slopes between the shoreline and the 240 m cover line. The first longwall advancing faces started in late 1976, and to date the mine has been operated on this system with faces to the east and west of the main Access Slopes. The mine normally has 3 working longwall faces in the Harbour Seam. The seam varies from 1.8 to 2.0 m in thickness, dipping at 8° with current workings being at approximately 600 m below seabed. The mine employs approximately 1200 men and works 15 8-hour shifts per week with a saleable coal target of 30,000+ tons.

Summary details of the methods and equipment used on the 10E and 9W longwall faces visited are given in Tables 4 and 5 respectively.

General comments include:

1. Advance Heading being tried on 7W face to alleviate severe weighting on main gate (bottom) roadways, and with use of yielding arches, to attempt to create roadway suitable for re-use for 8W face.

2. Immediate floor strata is good mudstone, whilst immediate roof strata is mudstone and shale, with 0.3 m above coal often proving difficult to keep up on faces and especially at face ends.

3. Extensive use of compressed air at pit.

4. Main Slopes driven by Dosco Mk 2A and 2B and Anderson Strathclyde RH25 Roadheaders.

2.6 PHALEN MINE - NEW WATERFORD

The visit to Phalen Mine on 13 November incorporated underground visits to 1W longwall retreating face and 2W maingate development drivage, and discussions with mine officials.

T. Baldwin	Mine Manager
C. Wilson	Shift Supervisor

Phalen Mine is an undersea mine developed adjacent to the Lingan Mine to work the Phalen seam some 180 m beneath the Harbour Seam workings in the Lingan Mine.

The mine commenced production from the first retreating longwall face in May 1987, the second in September 1987, and at full production is designed to reach an output of 35,000 tonnes per week. The Phalen Seam ranges from 2.45 m thickness in the East to 1.8 m in the West where the upper part of the seam splits. The mine operates 15 8-hour shifts per week and employs 590 men.

Summary details of the methods and equipment employed on 1W face and 2W MG development heading are given in Tables 6 and 7.

General comments include:

1. Because of the need to urgently replace production lost when #26 mine was closed due to the fire, 1W face is retreating inbye along roadways still being driven.

2. Gas makes at Phalen not yet determined, but initially expected to be in the 8-15 m^3/t range.

3. Most likely area for use of single entry short longwall is between main Deeps and Main Slopes (triangular shaped area).

3.0 U.K. VISITS

3.1 U.K. EQUIPMENT SUPPLIERS

Discussions were held on 15 November with several mining equipment suppliers to explore availability of equipment suitable for use with single entry short longwall retreating systems.

The relevant suppliers and equipment were:

- o EIMCO Mining Machinery International
  - EIMCO 913 FSV with Special Load Carrier, Diesel and Electric Drives.
- o Dresser Construction and Mining Equipment
  - BJD ACE & B59 Shearers including pickface and back face flushing and extractor drums
- o Gullick International
  - Face and Roadhead Powered Supports including Electronic Control
- o Winster
  - Prototype In Seam Miner
  - AFC Drives, in line, right angles plus auxiliary drive for coal sizer
- o Pitcraft Summit
  - Ventilation duct incorporated into AFC furnishings
  - Sure Power - Cableless power supply
  - Wabox - hoseless water supply
  - Rackatrac haulage
- o Wallacetown Simplex
  - Multiunit Gate End Boxes (A47)
  - Secondary End Box for Transformer to eliminate circuit breakers in single entry system (B80)
- o Kloeckner Becorit/Wultex
  - Curved AFC
  - Powered Supports
- o Fletcher Sutcliffe Wild
  - Modular In Seam Gate Conveyor with automatic loop take up and belt reel station

3.2 WISTOW MINE, SELBY COMPLEX

The visit to the Wistow Mine of the Selby Complex of British Coal on 16 November incorporated a visit underground to A14's single entry short longwall retreat face and discussions with mine officials.

G.E. Wilby	General Manager
E.A. Jude	Mechanical Engineer
J.A. Finneran	Deputy Mechanical Engineer
A. Davies	Safety Engineer

The Wistow Mine is the first of the 5 producing mines of the Selby Complex to enter production in the 2.4 m thick Barnsley Bed Seam. Its first longwall retreating face (138 m long) commenced in August 1983, and achieved weekly outputs of over 20,000 saleable tonnes before severe weighting and inrushes of water from the heavily watered lower magnesium limestone some 80 m above the workings stopped production. A second longwall was tried at reduced mining height (2.1 m), angled off end cleat and with other changes but this also proved unsuccessful, and the decision was taken to change to the single entry short longwall retreating system. This has now been successfully operated for the last two years with face lengths and pillar widths determined by the NCB rules for "Working under the Sea."

Wistow has mined 15 single entry panels and at the date of the visit, A14's face was completing the mining of a 1000 m long panel with a 35 m long face in a six week period.

Summary details of A14 single entry face and the adjacent A15 development drivage are given in Tables 8 and 9 respectively.

General comments made include:

1. Mine not liable to spontaneous combustion.

2. Floor hard mudstone.

3. Mine now working 1 single entry (west) and 1 standard longwall (east) plus 16 headings for main and face development

4. Wistow designed for 40,000t per week with labour force of 650. Current labour force of 800 will reduce as mine arterial roadways completed.

5. Mine presently producing coal at 0.85 - 1.40/GJ ($1.95 - 3.20/GJ).

6. Single entry faces originally on 9 man limit, now 12. Essentially for installation and salvage.

7. 12 man exemption requires:
   - BMI at #7 Chock
   - BMI outbye district
   - TX130 at blind end duct
   - CO monitor
   - Smoke detection at fans
   - Telephone/tannoy inbye, outbye and at blind end
   - Use of hand held MSA CH_4 detectors

8. Major operational problems:
   - Face creep
   - Ramming over AFC
   - Keeping up with development

9. Dust control good. With 130 l/min to each shearer drum, dust less than 7 mg/m^3.

10. Use of recirculation ventilation under consideration.

11. Single entry faces designed at 9.9 mm/m strain.

12. Single entry system under properly controlled conditions has proved very safe and cost effective.

3.3 SHERWOOD MINE - NOTTINGHAM

The visit was made to Sherwood Mine, Mansfield, Nottingham on 17 November and incorporated underground visits to the Dosco 3000 in-seam miner working in partial extraction panels, to 133's Single Entry Retreat face and discussions with mine officials.

D. Moult	General Manager
M. Orchiston	Deputy Manager
J. Whyatt	UnderManager
P. Dodd	Dosco Sales Representative

The Sherwood Colliery was originally developed in 1902 and has produced coal from seven different seams. It now mines the Deep Hard/Piper Seam (3.1 m); the Yard Seam (1.0 m) and the Blackshale Seam (1.9 m); the mine employs 780 men and produces approximately 18,000 saleable tonnes/week (36,000 t ROM) at an overall OMS of 4 tonnes. The mine is partially located under the residential town of Mansfield and is required to restrict or eliminate subsidence in this area. This has led to the development of the partial extraction systems using the DOSCO In Seam Mine and the Single Entry Short longwall retreat faces. This latter system is also being used at the adjacent Mansfield Colliery.

Summary details of the methods and equipment used in the In Seam Miner (ISM) drivage and on 133's Single Entry Face are given in Tables 10 and 11 respectively.

General comments include:

1. Seam moderately gassy. No trip outs in 1SM heading, but several on single entry face, usually at #3 chock where fringe encroaches on face.

2. ISM 3000 in Australia at 5.4 m wide and 3 m height averaging 9 m advance per shift with roof bolts only. 9 - 2.1 m long, 24 mm resin bolts and straps and mesh. Spacing 0.75 m, 5 vertical bolts and 2 inclined over each rib.

3. Dosco ISM 3000 will be used with JCM, each driving alternate 7.3 m wide headings with 7.3 m pillars to give 50% extraction.

4. Floor is strong mudstone with immediate roof being 0.5 m medium shale then strong mudstone.

5. Performance of other heading machines:

   Dosco Mk IIA - 45-50 m/week
   Dosco L1300 - 3 m coal - 100 m/week
   Dosco L1300 - 1 m coal, 2 m stone - 60 m/week

6. ISM Heading. If can use rock bolts and mesh instead of flat top arches and mesh in partial extraction, estimated saving of $700,000.

7. Use of full face in seam miner or single entry longwall retreating faces considered to be only viable means for partial extraction in conditions at Sherwood.

3.4 MINING MACHINERY DEVELOPMENT LIMITED

A brief visit was made on 17 November to MMD's works to see specialized stage loaders incorporating coal sizers and rock crushers. Mr. Alan Potts, Chairman showed a range of machines incorporating the new crushers. The items seen were more suited to high capacity faces with arch shaped roadways rather than in-seam operations because of their height requirements.

3.5 DOSCO OVERSEAS ENGINEERING LIMITED-TUXFORD

A visit was made to Dosco's works on 17 November to discuss the In-seam miner. A tour of the factory was taken and discussions held with:

Mr. J. Straughan - Export Director
Mr. P.N. Dodd - Regional Sales Manager

In the factory, both ISM2000 and ISM3000 In-Seam Miners were seen, together with the full range of Dosco roadheaders (Mk IIA, IIB, LA1300, Dintheader), a new continuous miner machine, and circular tunnelling machines using the Dosco cutting booms.

Dosco has made over 150 In-Seam Miners of which 25 are the new electric drive version. Electric ISM's are in use in UK, USA, S. Africa, Germany and Australia, primarily in-roadway drivage performances of up to 30 metres per day (2 shifts), 100 metres per week (10 shifts) and 1900 tonnes per week were being achieved with an ISM3000 in Australia, and 16 m/shift, 116 m/week (15 shifts) and 3000 tonnes per week in the UK also with an ISM3000.

Discussion centred around the single entry face system. Maximum length possible with an ISM was 17 m, however, John Straughan introduced the possibility of driving a 17 m advancing face, building a 7 m aquapack in the centre, thus forming two roadways which could be used for 'single entry' retreat with methane drainage from the second roadway. This system is being introduced in the Kembla Mine in Australia.

3.6 H.M. INSPECTORATE OF MINES - BOOTLE

A meeting was held with the Mines Inspectorate Division of the Health and Safety Executive at their headquarters in Bootle (Liverpool) on 18 November to determine the Mines Inspectorate's concerns with the single entry short longwall retreating system.

A. Davies	Deputy Chief Inspector
*R. Burnett	Principal Inspector of Mines
*F. Thompson	Principal Inspector of Mines
D. Laidlaw	Principal Inspector of Mines
*G. Goodlad	Senior Electrical Inspector
*R. Mitchell	Senior Mechanical Inspector
G. Green	District Inspector
A. Vincent	Inspector (Selby Area)
R. Johnstone	Principal Inspector of Quarries

* major contributors

HMIM have naturally approached the use of the Single Entry Short Longwall Retreating System with caution since its use adds a considerable element of risk when compared with a single drivage, due to the presence of caving strata and moving ground.

The major concerns are ventilation, frictional ignition, methane drainage, support and manning levels. Comments were made as follows.

361 GENERAL

A total of 14 mines have used or are using the single entry longwall system in the U.K. At the planning stage of any system, the mine manager has to notify the Inspectorate of the following:

- Intention to use the single entry system;
- Intention to use electricity in a single entry;
- Ventilation system and air quantities;
- An assessment of the friction ignition hazard;
- Any request for manpower limit exemption;
- Managers' support rules; and
- Codes of practice and procedures.

Under the Health & Safety Act, the Inspectorate has the power to serve a notice if there is a breach of the law, or to serve a prohibition order if a danger is apprehended. However, they prefer to work on a co-operative basis. The present Mines and Quarries Act and Regulations are being reviewed under the 1974 Health & Safety Act, and will be reissued under the Health & Safety Act in 15 distinct packages containing Regulations (embodying the M & Q Act) and Codes of Practice (embodying former regulations). These are expected to be issued in the next few years, meanwhile the Safety & Health Committee of British Coal are in the process of drafting procedures for the working of single entry retreat longwall faces and this draft is expected to be issued during 1988.

362 VENTILATION

This is the most critical aspect due to the need to ensure control of methane emissions from the waste area with the limited ventilation quantities available in the single entry system. The selected ventilation system should ensure continuity of ventilation at all times, and be chosen so as to minimize the risk of having to carry out a degassing operation.

If one accepts that a forcing ventilation system is better from the materials handling (lay flat vs steel duct) and the resistance aspects than an exhausting system, there are two basic ventilation systems possible using primary and secondary fans.

(a) Two parallel forcing ducts

The primary fan forces air through lay flat ducting in the entry to a booster fan at the stage loader and then through the face vent duct to the blind end.

The secondary fan forces air through lay flat ducting in the entry which is then discharged at the rear of the ribside roadway powered support (to hold back the gas fringe).

(b) Forcing system plus recirculation at face

The primary fan forces air through lay flat ducting in the entry to the rear of the ribside roadhead support. A second fan, mounted on the stage loader forces air through the face vent duct to the blind end, the systems overlapping in the region of the stage loader.

There are two concerns regarding continuity. Firstly, where the primary system is connected directly to the face ducting, the ventilation to the face is interrupted every time a length of ducting is removed as the face retreats. This can be overcome by the use of the recirculation system, of which there are over 50 approved and operating in the U.K. It has been proved that provided that the total quantity of air entering the system is sufficient to dilute the emitted methane, methane buildup does not occur in the recirculation or secondary system.

Secondly, loss of ventilation due to power outage either by cut off of power to the heading due to a monitoring device, which would result in the loss of any fan in the entry, or by a total power outage in the mine or district (loss of primary and secondary fans). Possible alternative ventilation power sources include design to use:

(a) pit pressure through doors;

(b) if compressed air is available, the use of 2 M120 Venturis in ducting.

Emergency ventilation should be sufficient to keep methane in system general body below 2%.

Wherever possible, single entry workings should retreat to the dip to ensure better gas control.

363 FRICTION IGNITION HAZARD

Single entry retreat longwall would only be allowed if the friction ignition index is low, i.e. no risk of presence of sandstone and similar strata in roof. Consideration should also be given to back face flushing of picks and ventilated drums.

Control of the friction ignition hazard is especially important since, with lower ventilation quantities on the single entry face, methane concentrations around the cutting drum are likely to be higher than on a conventional longwall face.

364 METHANE DRAINAGE

Where methane emission rates are such that gas concentrations on single entry faces cannot be controlled within the specified limits, some form of methane drainage may have to be applied. This could be in the form of:

- A pipe left in the abandoned roadway connected to a methane extraction range with regular stoppings in the abandoned roadway.
- Connection of the waste to another roadway near the face start line, or adjacent development; and use of methane extraction range.
- Drivage of wide (16 m) single entry with monolithic pack to form two roadways and conventional methane drainage from remaining parallel heading (gate road abandoned).

365 SUPPORT

Face entry/roadhead area is most critical. Roadway drivage supports should be steel. Use of roof bolts as additional support would be welcomed.

All roadway supports should be properly strutted to resist movement, and with bolted connections.

At face entry, there should be three powered supports that so always two supporting area, especially were face side legs are removed.

366 MANNING LEVELS

The normal limit to the number of men allowed in a single entry is nine, and an exemption is required to exeed this level.

If an exemption is granted, the following conditions usually are attached to the exemption:

- o Additional personnel from stated categories only.
  - management staff
  - safety services
  - examinations

- o Stipulated minimum ventilation quantities.

- o Stipulated monitoring.
  - CH_4 monitor - blind end and loader gate end.
  - Air velocity - face duct exit.
  - CO monitor - district.
  - Smoke detection - district.
  - Vibration - all fans.
  - Automatic fire damp dectectors - on face.

- o Telephone/tannoy system throughout district to blind end.

367 OTHER COMMENTS

- o Use of free steered vehicles is under examination as have lower accident potential due to lower manpower.

- o Use of locomotives permissible as governed by regulations.

- o Monitoring of total district from central (surface) control station desirable.

4.0 WEST GERMAN VISITS

Visits were made to three German equipment manufacturers (Eickhoff, Westfalia-Lunen, and Kloeckner-Becorit), to the Zolder Mine and discussions were held with Ruhrkohle A.G. (Neiderrhein Division).

4.1 EICKHOFF - BOCHUM

A visit was made to the Eickhoff works on November 20 to discuss the application of the ESA type machines to single entry working. A tour of the factory was undertaken and further brief discussions held on November 22 after the visit to the Zolder Mine.

P. Eickhoff	Managing Director
H-H. Klein	Export Sales Department
H. Cramer	Project Engineer (ESA)

Interest was expressed in the use of ESA type machine for (a) development drivage of roadway and face, and (b) mining of the short longwall retreating face.

The ESA machine originated at the Zolder Mine in Belgium as an hydraulically driven stable hole machine on an advancing longwall face.

The present machine range comprises a 60 kW range (ESA 60) and a 150 kW range (ESA 150) with a 300 kW machine under development. There are variants in each range as indicated in Table 12. As at April 1987, 69 ESA 60 and 13 ESA 150 machines had been sold. Of these, one ESA 60 is being used as the production machine in single entry retreat short longwall mining, and 21 (15-ESA 150) are being used for shortwall production, mainly in eastern Europe.

The ESA 60-L in the non-gassy lignite Stolzenbach mine of Preag AG has, since 1982, worked 21 single entry retreating longwall faces varying in length from 26 m to 50 m, with average daily face retreats ranging up to 10.3 metres/day (up to 1800 tpd). The machine at Stolzenbach was, unfortunately being overhauled on the surface in transit between faces, and could not be seen at work. Performance data from the shortwall ESA machines was not readily available, but has been requested.

A single entry face using the ESA machine was approved for the Ruhrkohle Neiderrhein Rhineland Mine, but never installed.

The ESA machines operate on either Eickhoff EKFO & EKF2 or Westfalia PF2 curved chain conveyors. The fixed curve type of conveyor is preferred to the roller curve type as less complex and requires less plan area. Cutter drums are made to suit each application and include a sumping in drum.

Eickhoff's approach to reliability and to reduce maintenance to a minimum fits well into the needs of single entry mining for equipment which will work for the life of the face with no breakdown.

The works were toured and the manufacture and assembly of shearers, roadheaders, conveyors and gearboxes for the mining and construction industries were seen. Eickhoff also manufactures its own computer cards for the control and monitoring of its equipment.

4.2 ZOLDER MINE - ZOLDER (BELGIUM)

A visit was made on 21 November to the Zolder Mine of N.V. Kempense Steenkolenmijnen to see two of their 17 ESA 60 machines at work, and to discuss the machines capabilities with the mine officials.

J. Legrand	Mine Director
R. Rosseels	Chief Engineer
W. Smolders	Production Engineer
P. Eickhoff	Director - Eickhoff
H. Surke	Eickhoff (Belgium)

The Zolder mine is the largest of only five mines still producing coal in Belgium, and by mid-1988, will be one of two mines (Beringen, the other) to remain in production. In 1986, Zolder produced 1.8 Mt saleable coal with a work force of 5,543 at an underground OMS of 3t/MS. The mine operates 10 advancing longwall faces, half equipped with Eickhoff EW170L Shearers and half with Westfalia ploughs.

In common with most western European mines, the coalfield is very disturbed geologically and face lengths and panel lives tend to vary considerably.

A visit was made to the 87/70 face at the 729 m level in the Houthalen section of the Zolder mine. A summary of the methods and equipment used on the face is given in Table 13.

General comments were made and include:

1. 87/70 face just commenced, advance 60 m.

2. Mine works ten different seams on horizon mining principle. Average seam thickness 1.1 m. Mine take covers 100 km^2 and contains 120 km roadways.

3. Extensive use made of compressed air.

4.3 WESTFALIA-LUNEN LUNEN

A visit was made to the Westfalia works on November 23 to discuss the application of the VME type machines to single entry working. A tour of the factory was undertaken and discussions held with Westfalia staff.

H. Leppkes	Project Director
V. Temme	Project Engineer (VME)

Interest was expressed in the use of the VME type machine for (a) development drivage of roadway and face, and (b) mining of the short longwall retreating face.

The VME machine orginated as a hydraulically driven heading and stable hole machine. Twenty-four of these machines are working in Europe, U.S.A. Mexico, Australia, Japan and Morocco.

The current version is electrically powered, and to date 13 of these are working in Germany, Canada, Morocco and England. Six machines are operating as the production machine on shortwall faces and one machine is working in phosphate in Morocco on a single entry system.

The basic VME has a 120 kW cutting motor driving twin 950 mm diameter cutting heads mounted on a transverse shaft. The machine is mounted on EKF1 curved conveyor and hauled by a hydraulically driven pretensioned 19 mm chain at a maximum of 22 m/min. For headings or faces longer than 30 m, a 22 mm haulage chain would be used.

Two versions of the machine are available. A low height (1.0 m) unit capable of cutting from 1.0 to 2.5 m height, and a high machine (1.5 m) with a cutting range of 1.5 to 2.85 m.

Conveyor length for the roadway heading or face can be made to suit as pans available in 0.75, 1.0, 1.5, 2.0 and 3.0 m lengths. VME can be used on chainless haulage, if required, and Westfalia have developed their own version (Panzer track) currently in use in Mexico.

Existing 90 kW drive on conveyor considered adequate for face lengths up to 30 m. For 50 m face, 120 kW drive necessary.

Phased pick face flushing is now available for the VME and should reduce dust problems in hard coal.

The single entry faces in phosphate at the OCF underground mines in Morocco average 26 m long, retreat 32 m/day in a 2.85 m seam, producing 2850 t/day at a face OMS of 69 t. The cutting is considered to be easy though occasional hard bands are present.

A single entry short longwall system is currently being manufactured for use at the Norgrad Coal Mine in Hungary. This is due to start in May 1988 and will comprise a 120 kW cutting unit for the 2.0 m seam. Face length is 50 metres. The VME will be mounted on a heavier duty conveyor (PF 230) with a chain speed of 1 m/sec and a maximum capacity of 1000 tph. Machine haulage will be by hydraulically driven chain (probably 22 mm).

When used on shortwall faces, the VME operator travels with the machine which takes cuts along the full length of the face. The machine controls are still mounted on the cutting unit, and a Bretby type cable handler is used on the longer faces. Sumping in is limited to less than half the drum diameter unless the machine is shuttled back and forth.

The longest shortwall which has been worked, to date, is 26 m and the widest heading which has been driven is 9 m. VME's have successfully worked on gradients of 45° using powered supports to control the machine.

Installation of machine and conveyors is claimed to take only 3 days.

Westfalia have developed a prototype split boom VME with each head on an independent boom. This is currently being tried in the potash mines of Kali-und Salz in Germany. The machine has a cutting range of 1.5 to 2.8 m and in a 2.2 m high x 8.5 m wide roadway is achieving (with rock bolt support) advances of 250 m in 20 shifts. A split push/pull anchorage system is used to move the machine. This also carries the rock bolting equipment.

A tour was made of the factory to see VME, ploughs, AFC, roadheaders, tunnelling units and special conveyors being manufactured and assembled.

4.4 KLOCKNER-BECORIT, CAUSTROP RAUXEL

A visit was made to the Klockner Becorit works on the morning of 24 November to discuss the curved AFC and the emergency escape system as applied to single entry longwall systems.

H. Oppenheimer	-	North American Sales
H. Klamer	-	Local Sales
N. Blaser	-	S. African Sales

Klockner have developed a new curved AFC using a harness chain whereby the drive is transmitted to the flight harness rather than the chain. This conveyor is designed for long longwall faces using 720 kW installed power and an oval 38 mm chain. One installation presently working with total length of 380 m, 30 m in tailgate curving onto 300 m face curving into 50 m length in maingate. Capacity with 2 x 160 kW drives in TG and 2 x 200 kW drives in MG and 600 mm pans is claimed to be 2000 tph.

System would be too big for single entry, both in power, and particularly in space taken up by roller curve at face end. Latter would make effective support at face/roadway interface very difficult.

Support density requirements in Germany at 40 t/m^2 are considerably less than those in UK and North America (60-80 t/m^2).

The emergency escape system designed by Klockner-Becorit for use with their 2 leg shields at Rheinland Mine was approved by the German Inspectorate Landesoberbergamt (LOBA).

This consisted of a steel box placed continuously along the face between the legs and the lemniscate linkage of the shield. The box had a width of 850 mm, a height of 750 mm and a sectional area of 0.6 m^2. The distance between the shield legs and linkage was sufficient to allow the shield to advance with the box stationery and then advance the entire length of the box in one movement using its own set of rams. Access doors to the box was

placed every third shield. The dimensions and shape of the box were such that it was not affected by any part of the shield, even when the shield was in the closed position.

The German mines regulations require two ways out of each working face where strata is caved. This device was necessary because no exemption to the regulation would be given by the authorities. This escape box also acted as the ventilation duct to the face end. As a prerequisite to its use, a length of ducting has been successfully proven in use underground.

4.5 RUHRKOHLE AG - NIEDERRHEIN DIVISION - DUISBERG

A meeting was held on 24 November with Dr. H. Boldt, Production Director of the Niederrhein Division of Ruhrkohle to discuss the application of single entry longwall retreating faces in Germany.

Dr. Boldt was previously the Mine Director at the Rheinland Mine of Ruhrkohle where he had designed and had approval for the working of two single entry retreating longwall faces. Approval was given by LOBA in May 1985, but before the schemes could be implemented, Dr. Boldt was promoted to the Duisberg headquarters and the new mine management have not yet proceeded with the single entry scheme.

The proposal was to mine two remnants of coal between faults, and through which an access roadway had been previously driven. Each face - 33 m long would be successively mined along the roadway. The roadway is supported by 3 piece arches at 1 m intervals which are fully concreted over their crowns to give full support (not point load support) to the roof. In these circumstances, and with 4 - 2 m roof bolts set over the face entry, 2 to hold the arch crown, and 2 to hold the face lip, the authorities do not require any additional support in the roadway. A 1.2 m wide 'Aquapack' is built at the roadside behind the face and the arch leg is replaced. This is considered to be sufficient to keep the roadway open for intake air, conveying coal and for re-use for the second face.

Dr. Boldt said that the conditions laid down by LOBA, for the use of the single entry system, were very stringent, especially in relation to the control of methane. The main criteria were:

- minimum face quantity 7 m^3/s.
- combination electric/compressed air fan.
- minimum velocity in roadway 0.5 m/s.

- CH_4 monitoring with automatic cut off of electricity plus acoustic and optical warning.

- cut-off limits to face equipment are:

  Air flow <11 m^3/s - cut off 0.3% CH_4
  Air flow 11-17 m^3/s - cut off 0.2% CH_4
  Air flow >17 m^3/s not allowed on face

- Special escape rules using box and special inspections by ventilation and rescue inspectorate.

- If CH_4 emission rate exceeds 2 m^3t mining must cease for good.

Dr. Boldt felt these very stringent limits reflected the experience of the President of LOBA who had, when a mine manager, lost many men in a methane explosion.

Dr. Boldt was still very keen on working the system, especially in view of the excellent results being achieved in the UK, and was hopeful that an installation in a German hard coal mine would be forthcoming soon. The Rheinland installation was planned to produce 700 t/shift (10,000 t per week) from a 33m long face in the 2.05 m high Hermann-Gustav seam.

4.6 DOWTY MINING EQUIPMENT (UK) - FRANKFURT

A meeting was arranged in Frankfurt with Dowty Mining Equipment of Tewkesbury UK (Paul Griffin, Overseas Sales Manager) to discuss single entry faces and Dowty equipment, with particular reference to the Gretley Colliery installation in Australia, which was the first installation specifically system designed for single entry operations. The Gretley system is based on the BJD ACE SERDS Shearer, Halbach & Brown curved conveyor and Dowty 2 leg roof shields of special compact length (4 m for transport). Face lengths will range from 25 m to 41 m with a daily retreat of between 60 m and 40 m expected.

The Dowty supports, set at 2.0 m centres, have special seals to force air along the face and to prevent air leaking with the waste. The blind end support also contains a special side (cusp) support to prevent coal spalling at the face end.

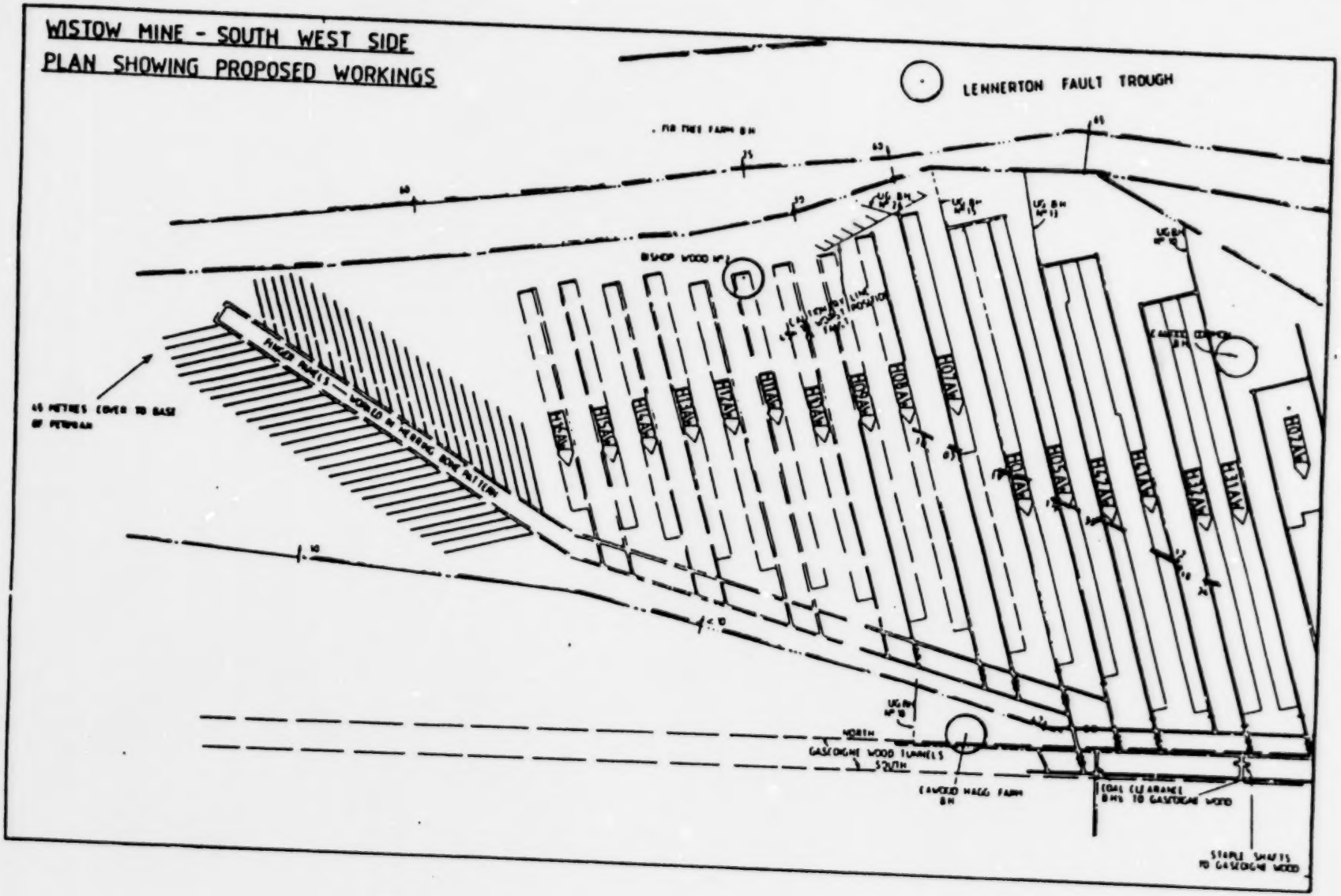
In the Gretley system, the air returns down a bleeder roadway at the ribside but this is not maintained.

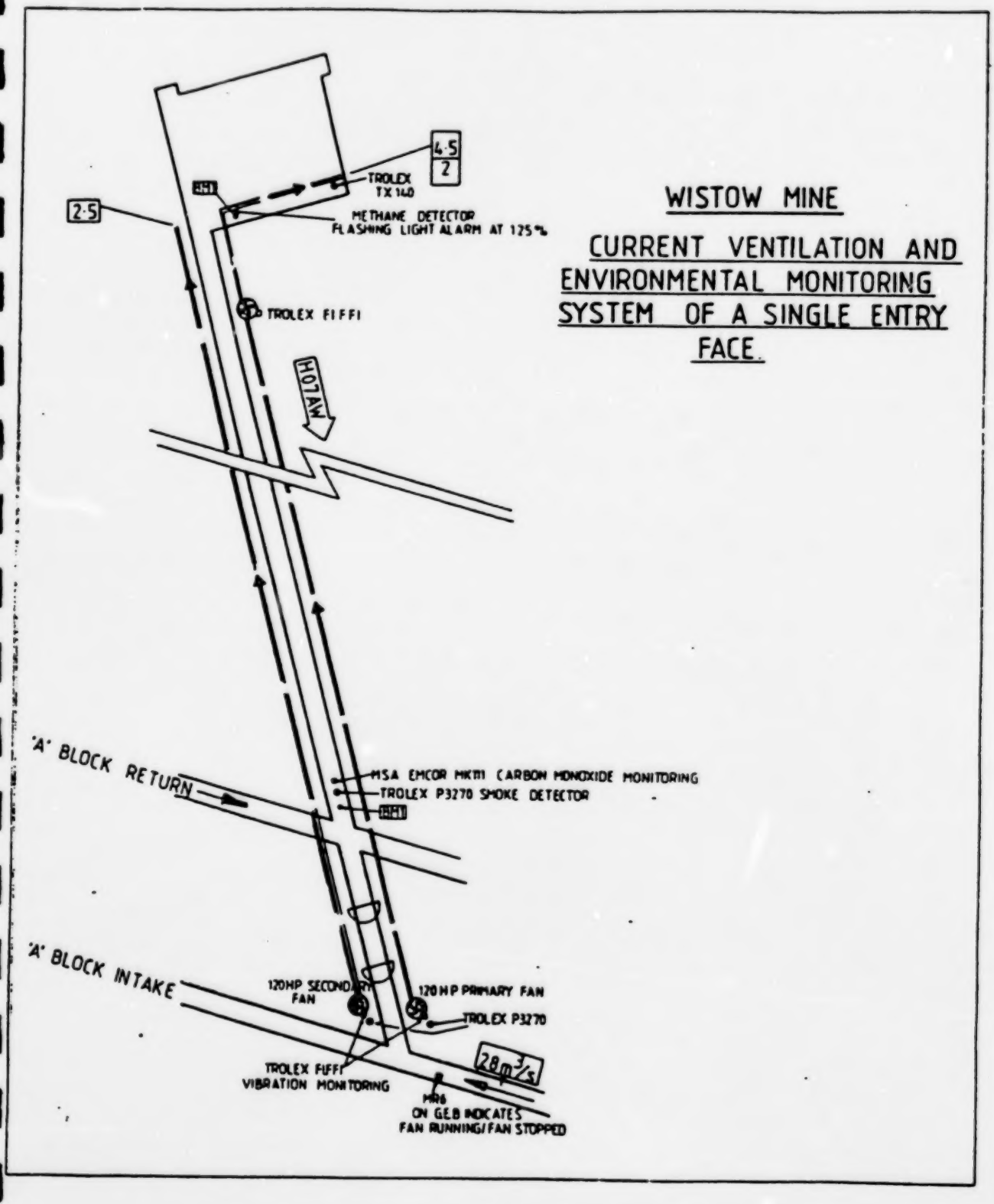
On the very short single entry or shortwall faces, support cycle time becomes very critical of the full capacity of the Shearers is to be achieved. Cycle times must not exceed 8-10 secs. This is only possible using electronic control, which is an essential for effective use of a single entry system.

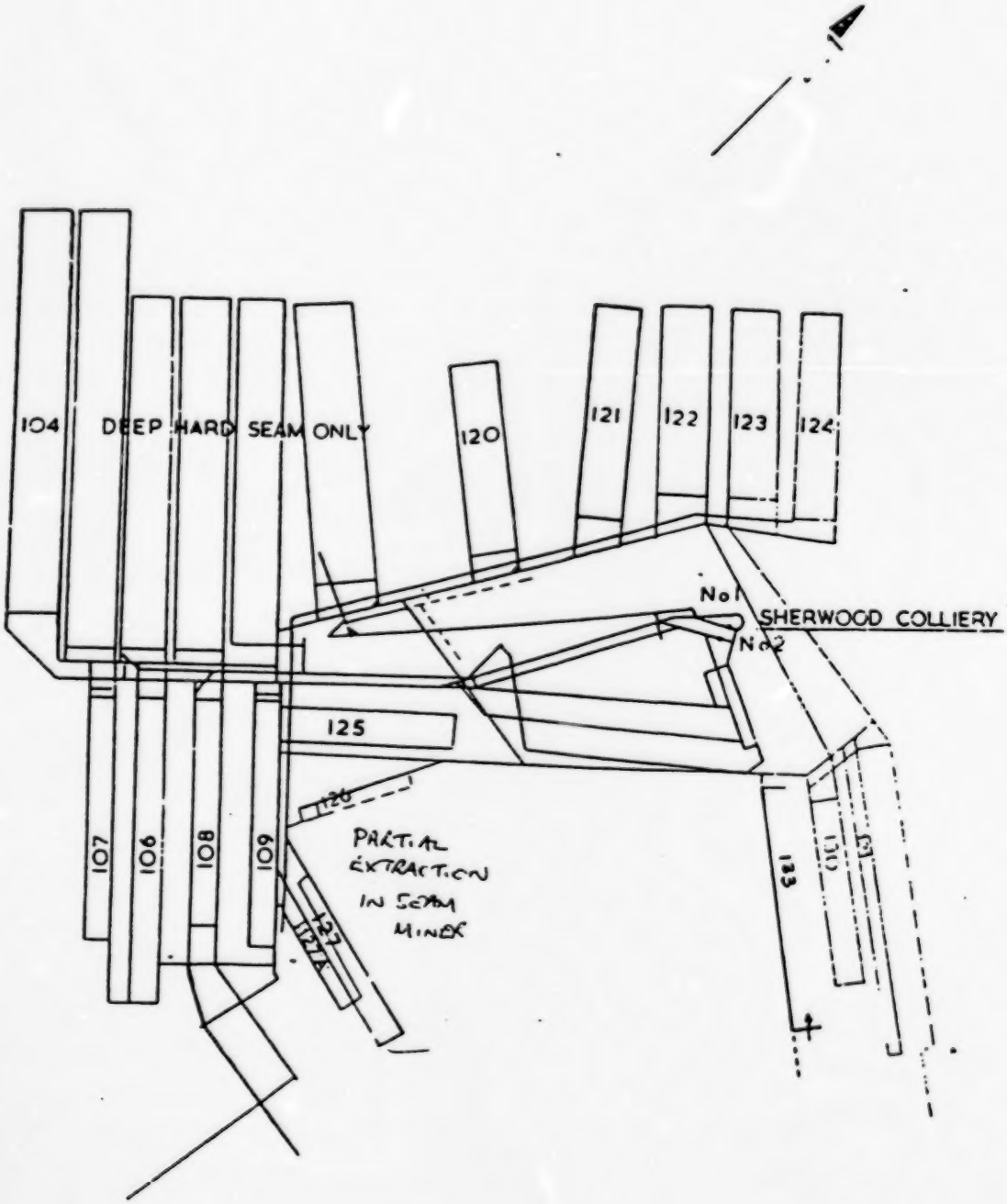
The roadhead is supported by 2 2.0 m wide 2 leg shields. In the Gretley system, the roof is not expected to cave and support setting load (80% of yield) is considered to be more important than yield load, with positive set to prevent overpressurization.

The power pack for the face is remotely located, though flow, pressure and the effect of gradients has to be taken into account. Back pressure in lines should not exceed 3.5 Mpa.

Roadhead/Face Entry supports can be specially designed (Dowty Hucknall) to meet the specific needs. Three supports in a roadway are possible, and could include 4 in line or 8 leg E type sliding beam supports.


WISTOW MINE - SOUTH WEST SIDE
PLAN SHOWING PROPOSED WORKINGS
LENNERTON FAULT TROUGH
FIR TREE FARM BH
BISHOP WOOD No 2
45 METRES COVER TO BASE OF PERMIAN
FINGER PANELS WORKED IN HERRING BONE PATTERN
H15AW
H14AW
H13AW
H12AW
H11AW
H10AW
H09AW
H08AW
H07AW
H06AW
H05AW
H04AW
H03AW
H02AW
H01AW
H02AW
NORTH
GASCOIGNE WOOD TUNNELS
SOUTH
CAWOOD HAGG FARM BH
COAL CLEARANCE BHs TO GASCOIGNE WOOD
STAPLE SHAFTS TO GASCOIGNE WOOD


WISTOW MINE
CURRENT VENTILATION AND ENVIRONMENTAL MONITORING SYSTEM OF A SINGLE ENTRY FACE.
4·5
2
TROLEX TX 140
METHANE DETECTOR FLASHING LIGHT ALARM AT 1.25%
2·5
TROLEX FIFFI
MWLOH
'A' BLOCK RETURN
MSA EMCOR MKIII CARBON MONOXIDE MONITORING
TROLEX P3270 SMOKE DETECTOR
'A' BLOCK INTAKE
120HP SECONDARY FAN
120HP PRIMARY FAN
TROLEX P3270
28m³/s
TROLEX FIFFI VIBRATION MONITORING
MR6 ON GEB INDICATES FAN RUNNING/FAN STOPPED



SHERWOOD MINE

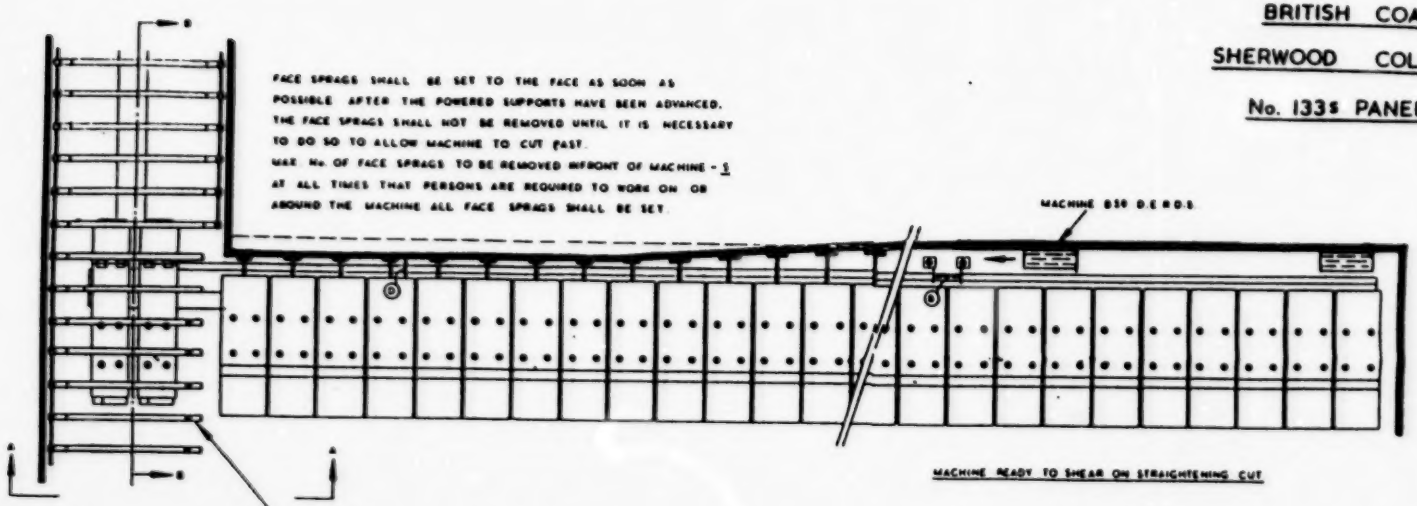
NATIONAL COAL BOARD NOTTINGHAMSHIRE AREA SHERWOOD COLLIERY.

DEEP HARD / PIPER SEAM

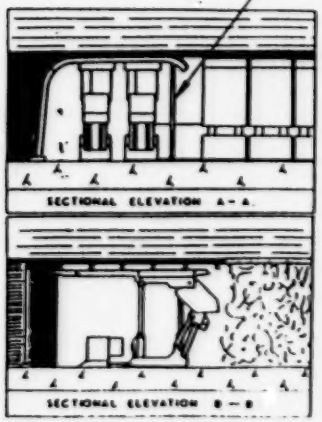
BRITISH COAL.

SHERWOOD COLLIERY.

No. 133s PANEL.



NOT TO BE SCALED.



ADDITIONAL GENERAL INSTRUCTIONS

No person shall be on the face side of the conveyor unless temporary supports at 0·9m. intervals are set.
Should any falls occur temporary supports shall be set and the roof and sides made safe by dressing before the removal of any debris.
Chocks shall be built on the natural floor and built tightly to the roof.
Broken or displaced supports shall be renewed forthwith and only supports of an approved type shall be used.
During drawing off operations in wastes all supports shall be withdrawn by means of a safety contrivance.
All distances are MAXIMUM unless otherwise stated.
Nothing in these rules shall prevent any workmen setting additional supports.
Supports set for the purpose of leaving in must be set in addition to the supports shown.
All arches to be fully strutted.

THIS PLAN SHOWS THE SYSTEM OF SUPPORT WHICH WILL BE INCLUDED IN THE SUPPORT RULES.

SIGNED _____ COLLIERY MANAGER.

DATE 25-5-87 PLAN REF -SC/SP/133.2.

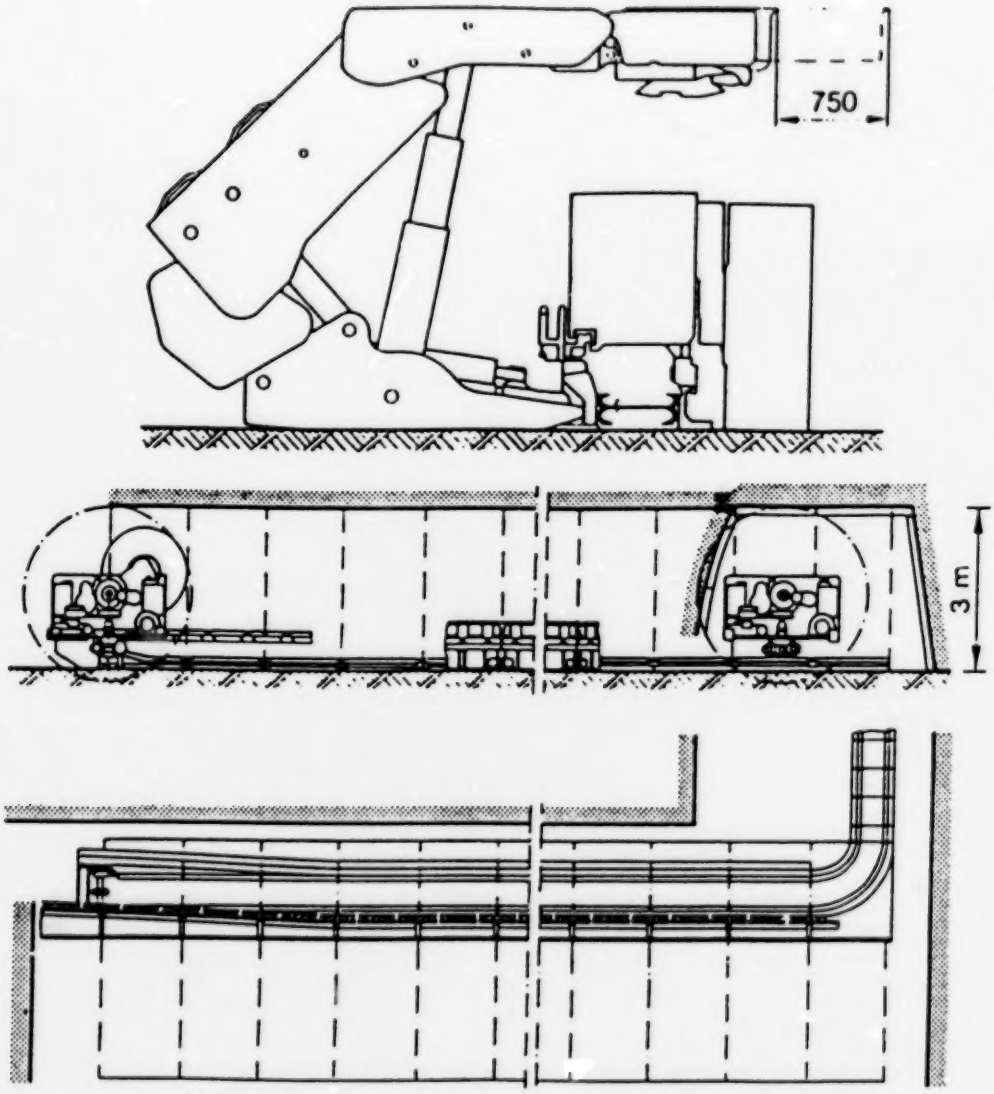
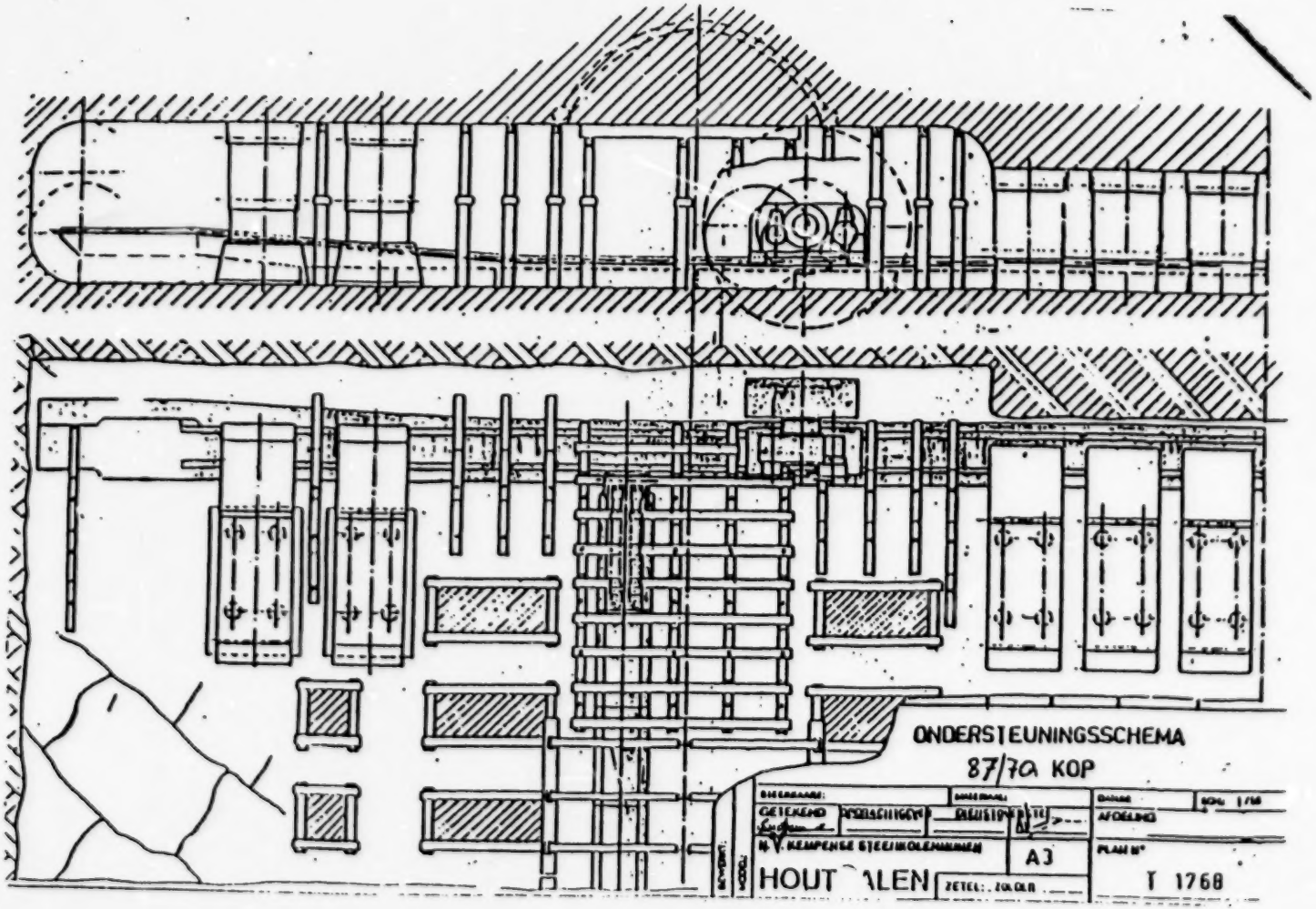


Fig. 3. The standard shield (top) and the shortwall face equipment (bottom).

STOLZENBACH MINE

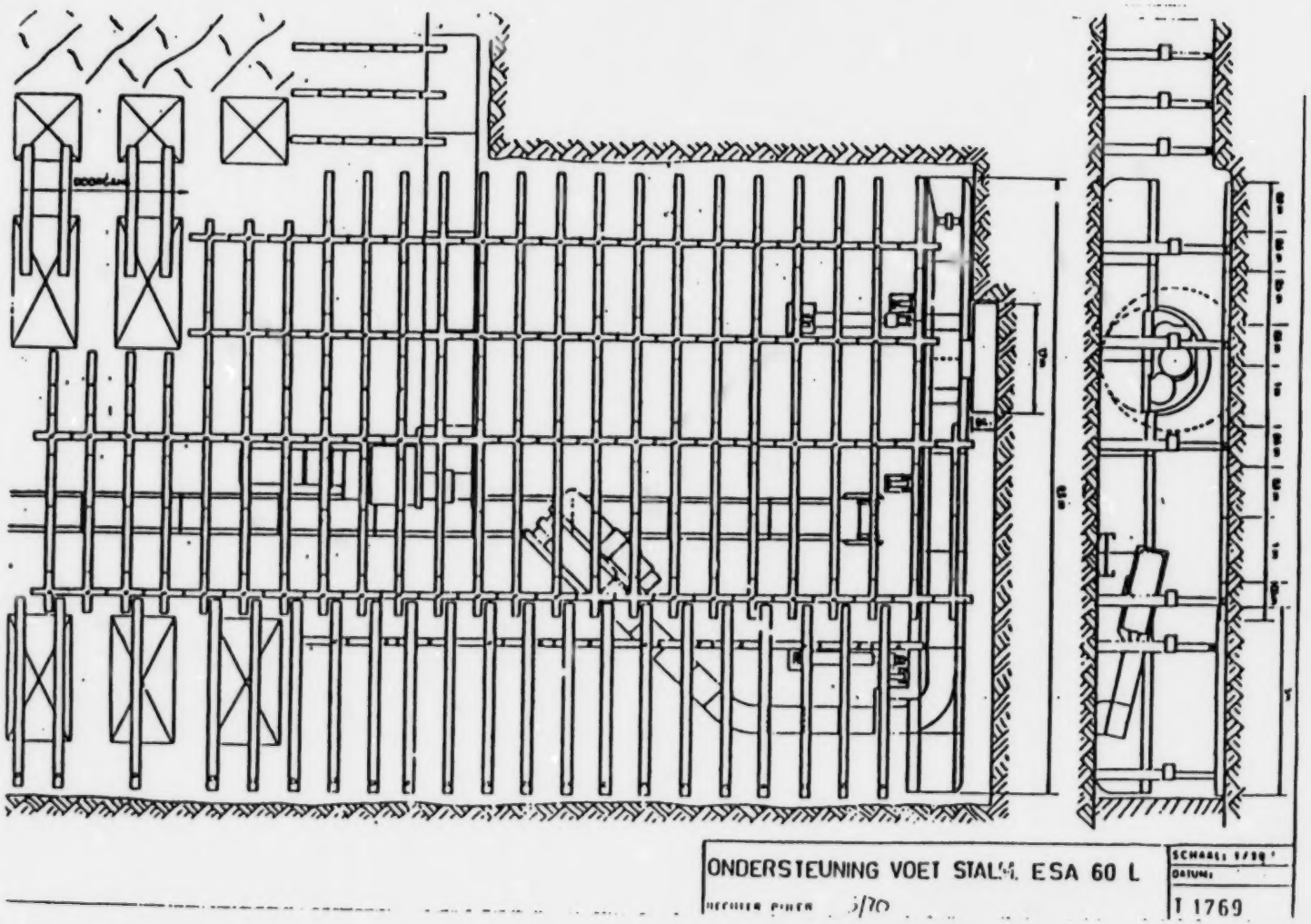
ZOLDER MINE

T.G. STABLE



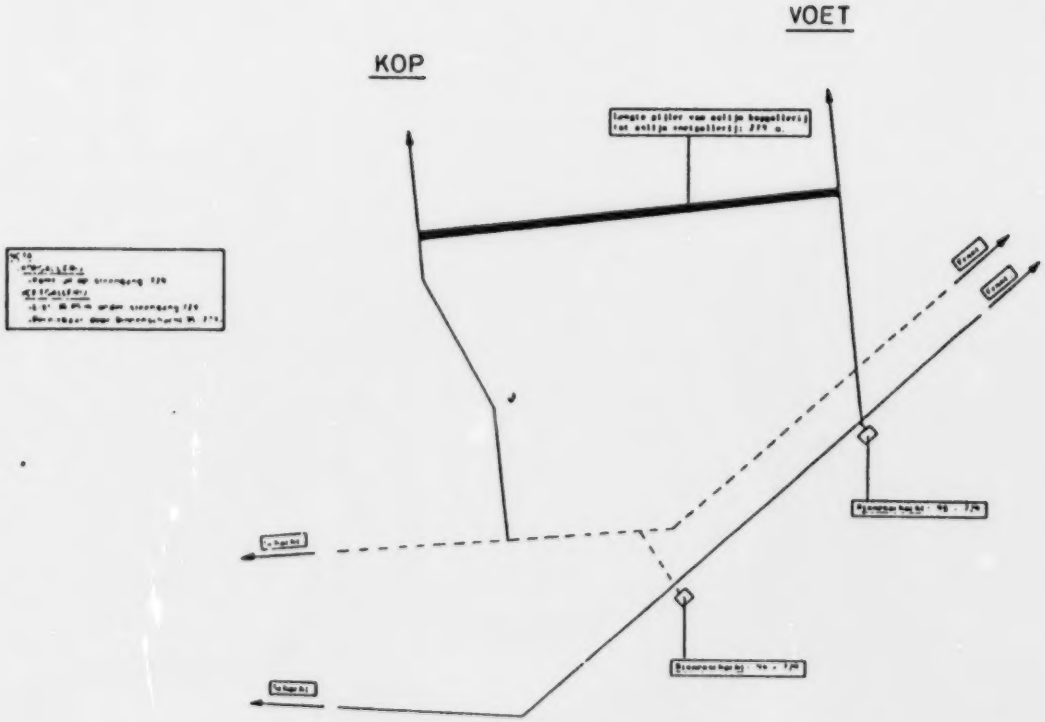
ZOLDER MINE

M.G. STABLE

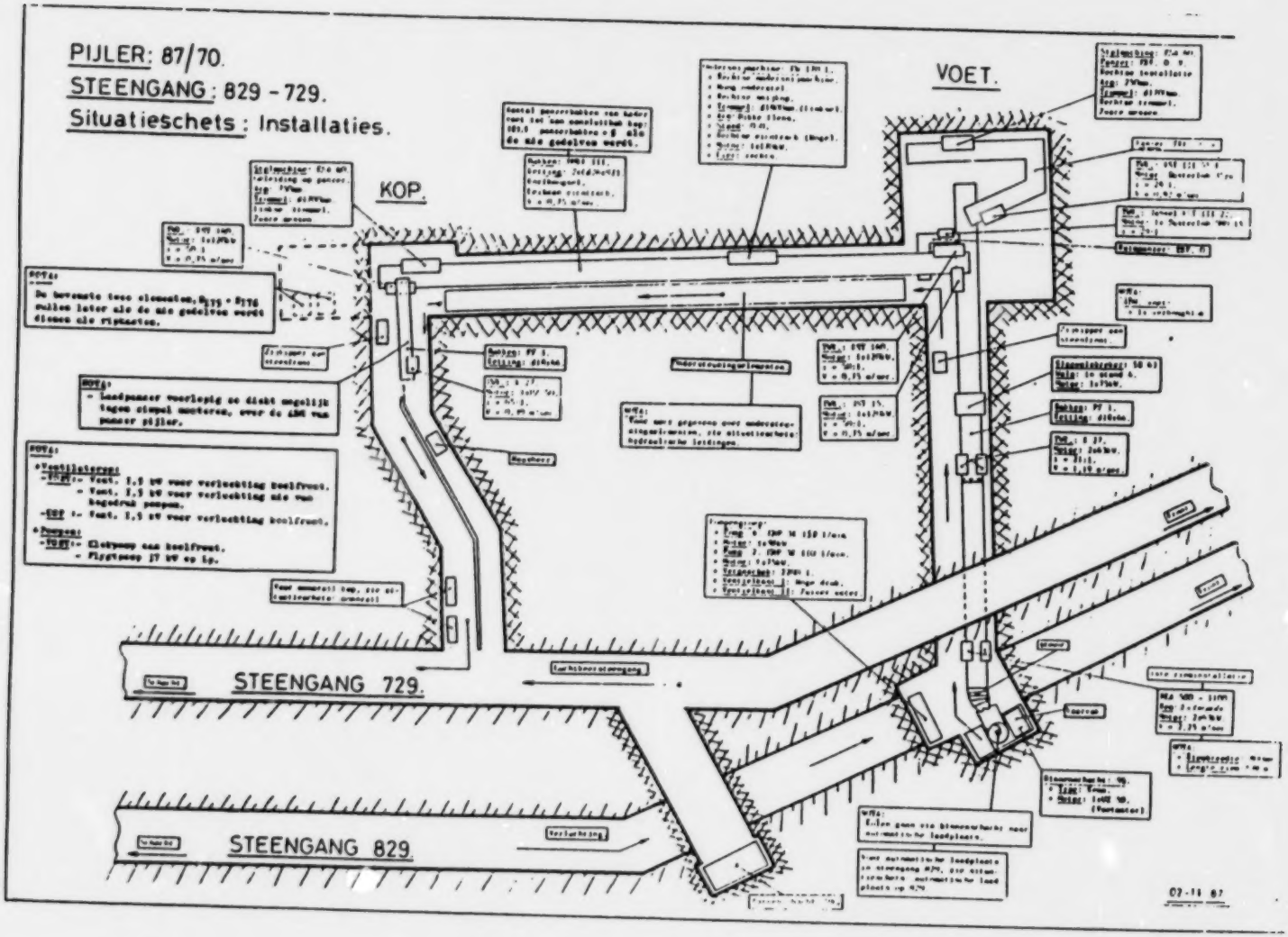


ZOLDER MINE
FACE LAYOUT

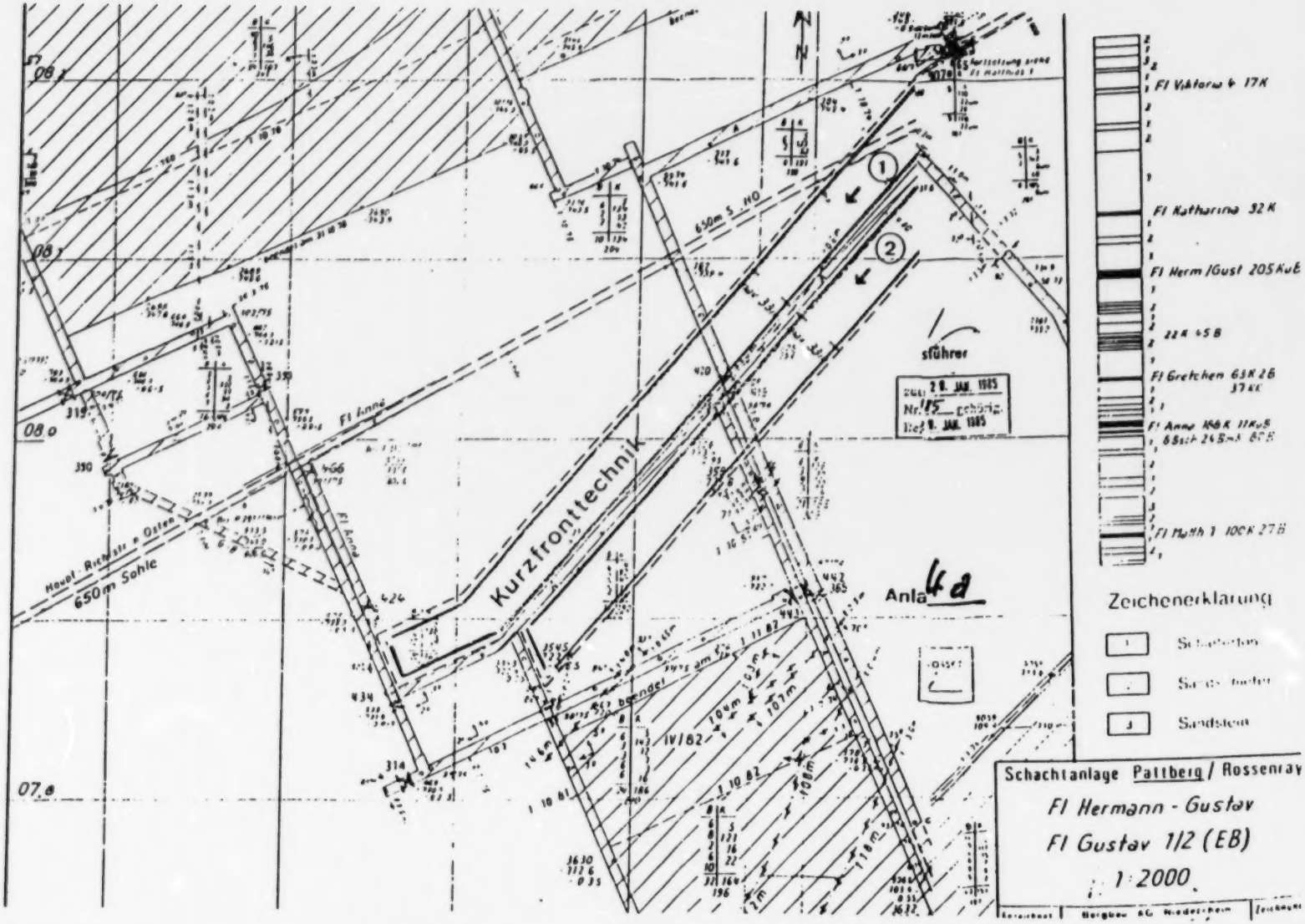
PIJLER: 87/70.
STEENGANG: 829 - 729.
Situatieschets: Geologisch ontginningsplan.



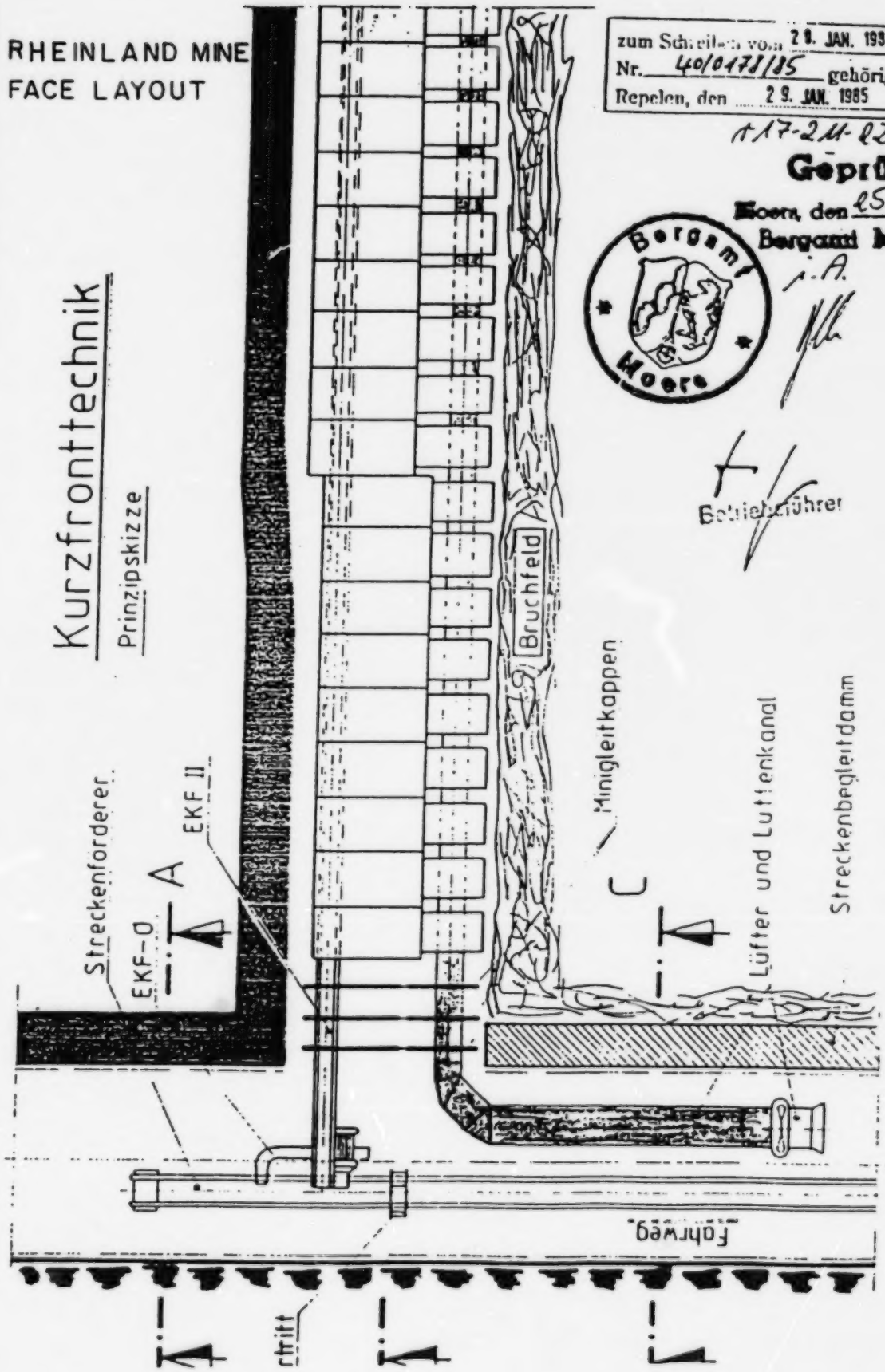
ZOLDER MINE
EQUIPMENT LOCATION



RHEINLAND MINE
SINGLE ENTRY FACES



RHEINLAND MINE
FACE LAYOUT



zum Schreiben vom 29. JAN. 1985
Nr. 40/0178/85 gehörig.
Repelen, den 29. JAN. 1985

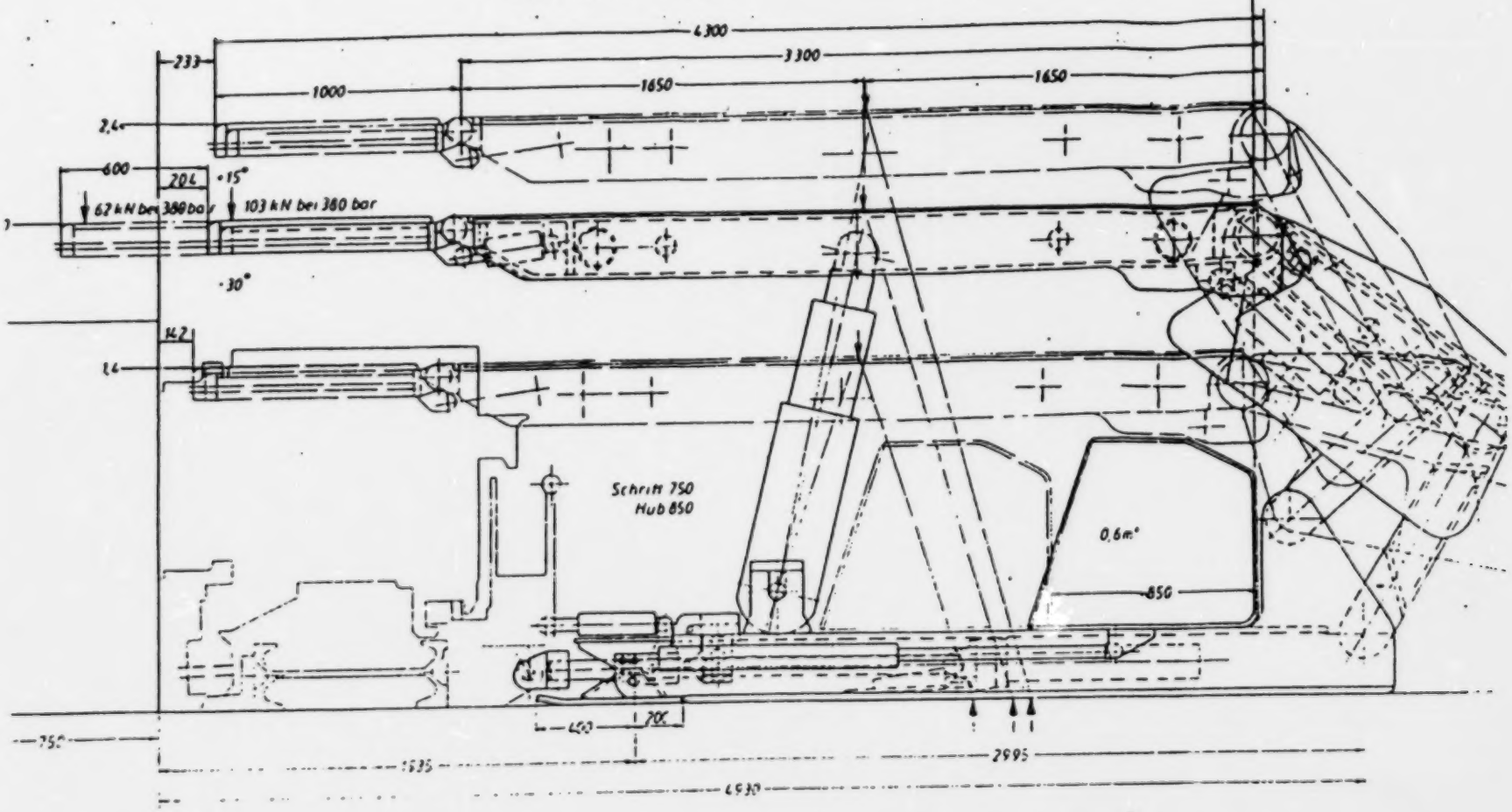
A17-2M-02-12

Geprüft
Moers, den 25.03.85
Bergamt Moers
i.A.

Bergamt Moers

Betriebsführer

RHEINLAND MINE
ESCAPE TUBE

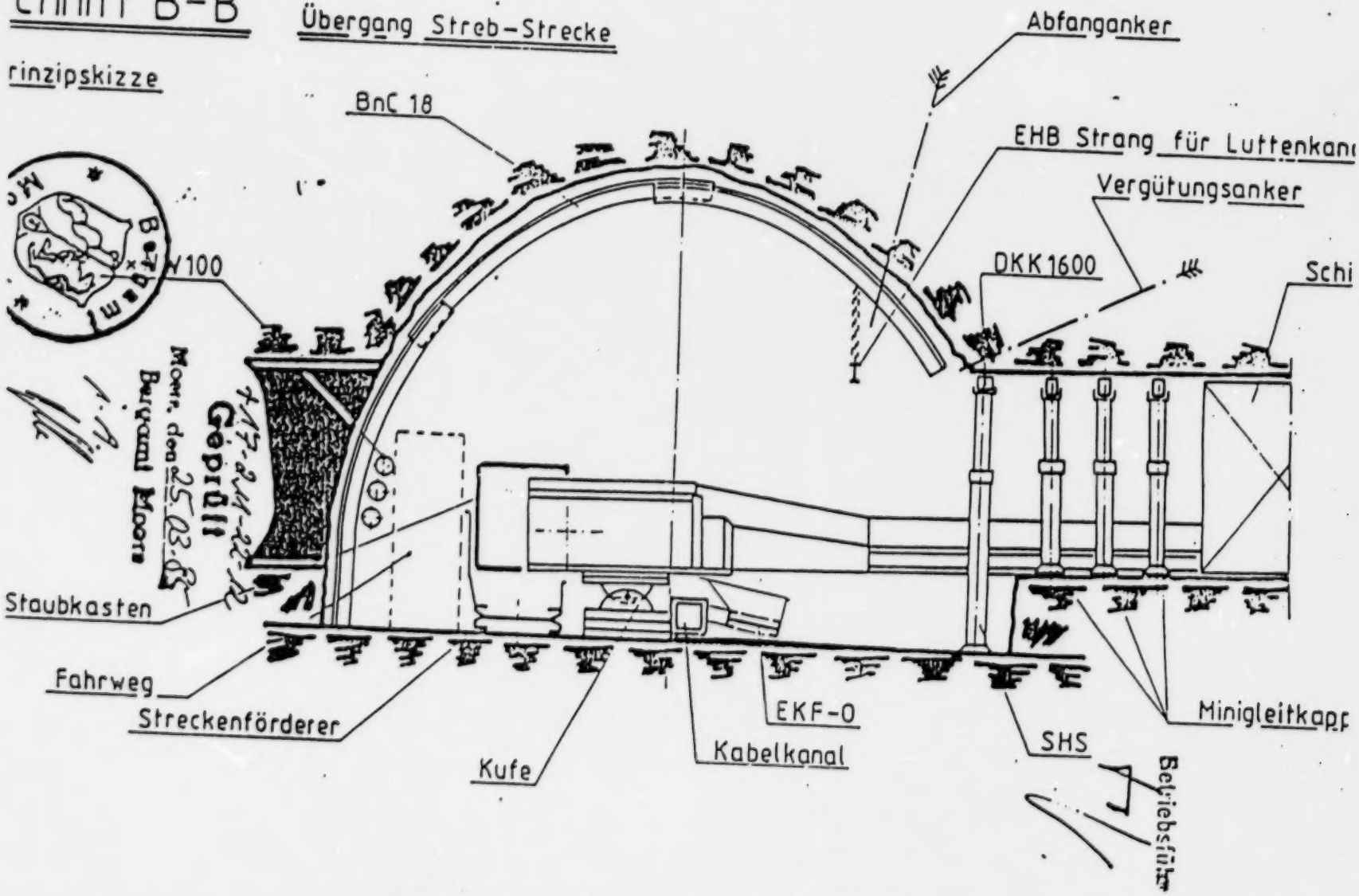


RHEINLAND MINE
FACE END SECTION

chnitt B-B

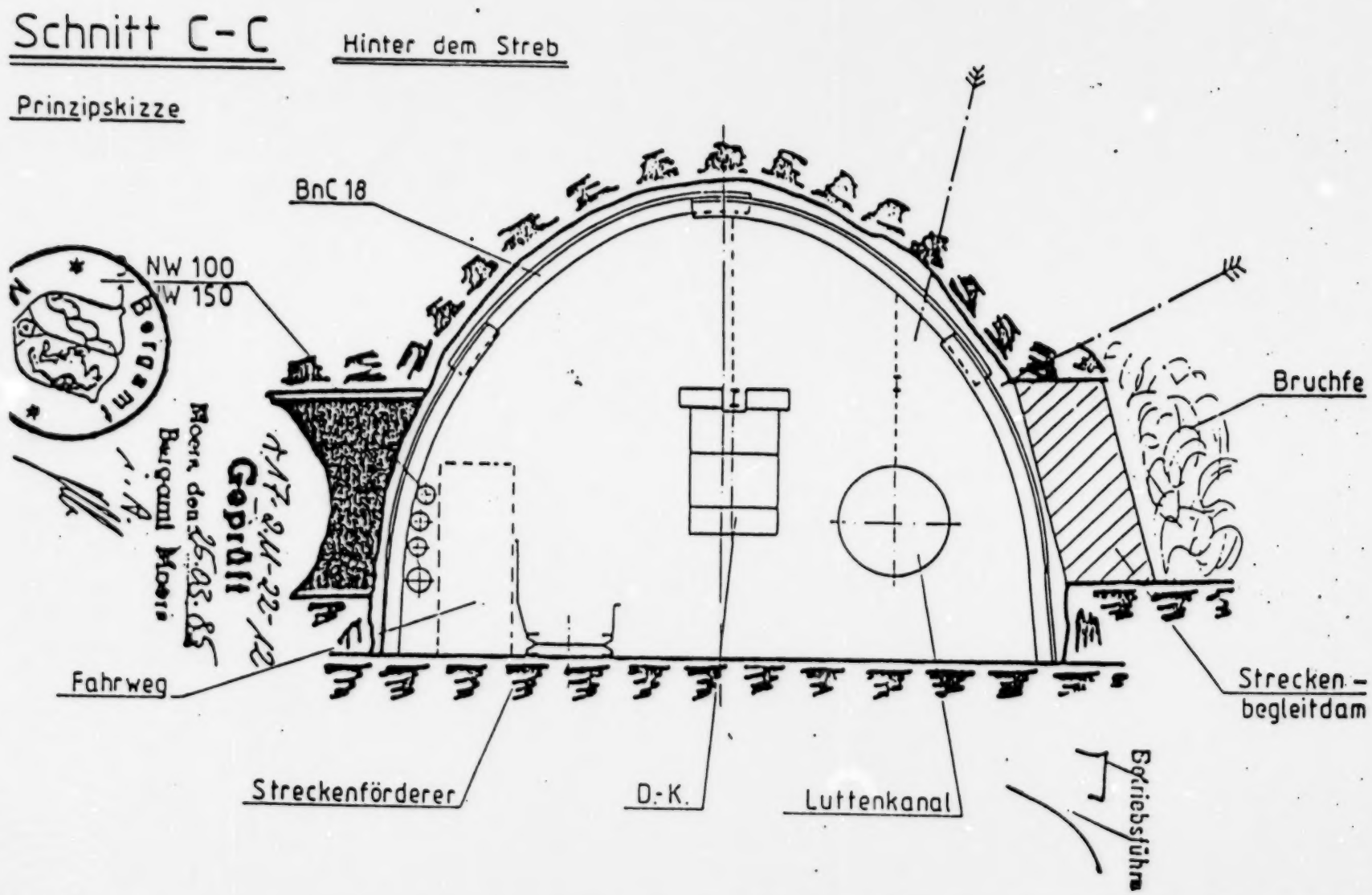
rinzipskizze

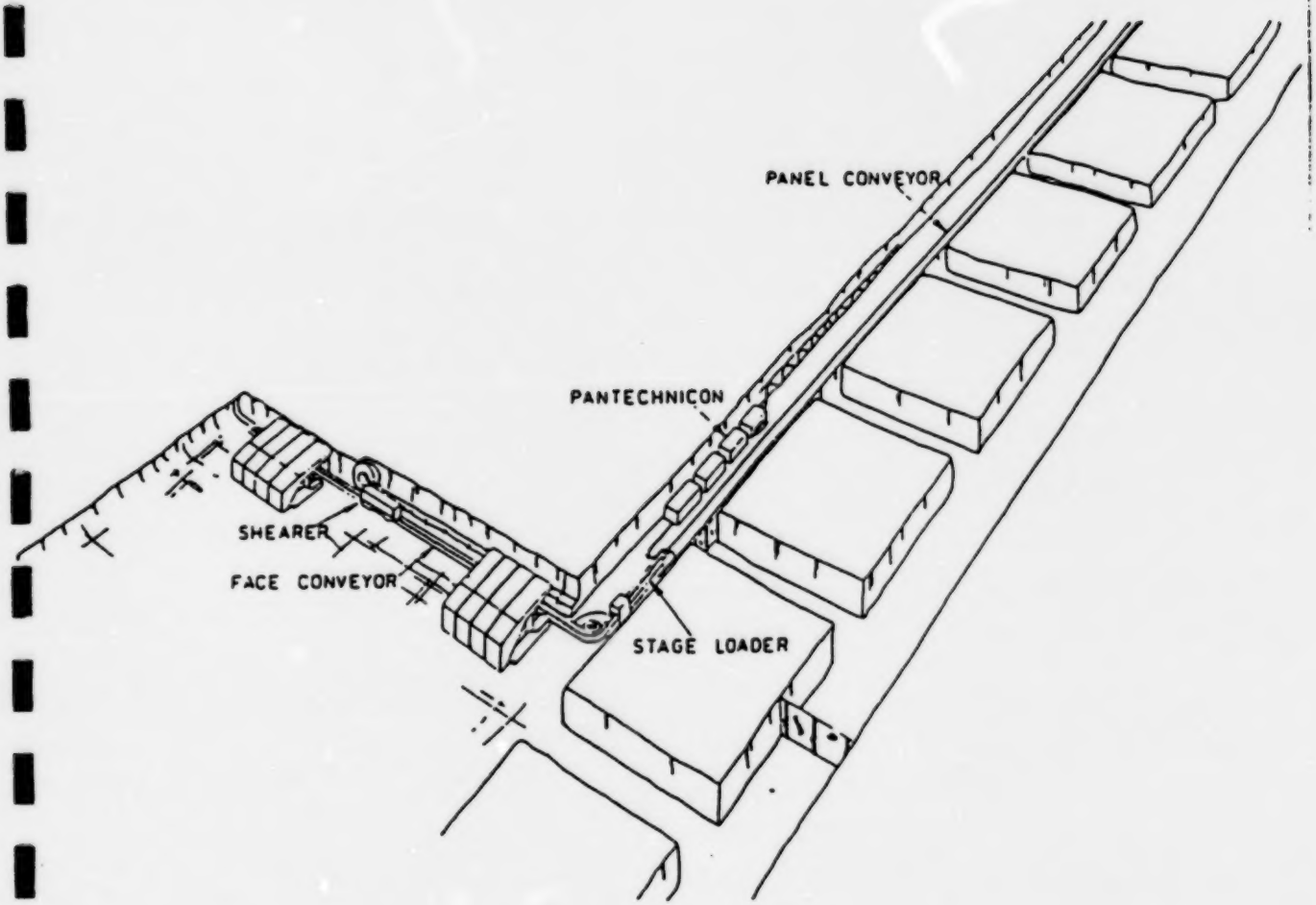
Übergang Streb-Strecke



Geprüft
Bergamt Moers
Moers, den 25.03.85

RHEINLAND MINE
ROADWAY SECTION





MINIWALL MINING SYSTEM

GRETLEY MINE

TABLE 1

VISITS PROGRAM

Monday, 9 November	- CANMET Coal Research Laboratory, Sydney, N.S. - Labour Canada, Sydney, N.S. - Cape Breton Development Corporation, Glace Bay, N.S.
Tuesday, 10 November	- Prince Mine (CBDC), Pt. Aconi, N.S. - Coal Research Laboratory, Sydney, N.S.
Wednesday, 11 November	- Remembrance Day
Thursday, 12 November	- Lingan Mine (CBDC), Lingan, N.S. - Cape Breton Development Corporation, Glace Bay, N.S.
Friday, 13 November	- Phalen Mine (CBDC), Lingan, N.S.
Sunday, 15 November	- U.K. Mining Equipment Suppliers, York, U.K.
Monday, 16 November	- Wistow Mine (British Coal), Selby, U.K.
Tuesday, 17 November	- Sherwood Mine (British Coal), Mansfield, U.K. - MMD Ltd., Somercotes, U.K. - Dosco Engineering, Tuxford, U.K.
Wednesday, 18 November	- H.M. Mines' Inspectorate, Bootle, U.K.
Thursday, 19 November	- Gebr. Eickhoff, Bochum, FRG.
Friday, 20 November	- Zolder Mine (Kempense Steenkolenmijnen), Zolder, Belgium
Saturday, 21 November	- Eickhoff, Bochum, FRG.
Monday, 23 November	- Westfalia-Lunen, Lunen, FRG.
Tuesday, 24 November	- Ruhrkohle AG- Neiderrhein Division, Duisburg, FRG - Klockner Becorit - Castrop Rauxel, FRG. - Dowty Mining - Frankfurt, FRG

TABLE 2

6W LONGWALL RETREAT FACE - PRINCE MINE

Depth of Cover	230 m
Seam Height	2.54 m
Face Length	113 m
Panel Length	2744 m
Pillar Width	65 m
Gradient	2°-3° along face
Shearer	- Anderson Strathclyde AMBROAS DERDS. (225 kW) - Dynatrack haulage - Powered cowls - 3 start 2.0 m dia. drum with pick face flushing and parrot type picks - 0.66 m web. - Cutting speed 8 m/min. max.
AFC	- Halbach & Braun 2 x 26 mm outboard chains, 1 metre flight spacing - 105 kW in line drives at Main Gate and Tail Gate
Stage Loader	- As for AFC but with single drive and 0.5 metre flight spacing - Coal sizer on stage loader - 10 m overlap over gate conveyor
Face Supports	- Hemscheidt 2 x 320 t shields with powered forward cantilever (68) or with rigid canopy (6) - Operated on Manual Adjacent control - Equipped with Face Lighting
Roadway Supports	0.15 m x 0.15 m x 4.27 m long RSJ with pin jointed steel legs, lagged and strutted
Roadhead Supports	- Tail Gate - 2 - 4 leg anchor chocks with extended canopies - Main Gate - 2 - 4 leg anchor chocks with extended beam and fifth leg - Roadhead chocks normally long enough to support 2 Roadway girders with face side legs removed
Gate Conveyor	- 3 - Huwood Scout 90 kW Drives in series (approximately 900 m long each) with 15 m loop take ups. 0.92 m wide belt

TABLE 2 (Cont'd)

6W LONGWALL RETREAT FACE - PRINCE MINE

Ventilation	- On Face - approximately 19.4 m^3/sec. - CH_4 - 0.2% to 0.4% when cutting - methane emission 0.5 m^3/t	
Power	- 1100 V - All electric control boxes, powered support power pack, transformers, etc., on rail mounted units moved back every 100 m. Hoses and cables to face carried on mono-rail.	
Face Manpower per Shift	- Shearer	2
	- AFC Rams	1
	- Face Supports	2
	- Main Gate End	4
	- Tail Gate End	3
	- Stage Loader	1
	- Console	1
	- Mechanic	1
	- Electrician	1
	- Supervision	1
		17
Performance	- max. 2 shears/hour	(520 t)
	- max. 12 shears/shift	(3100 t)
	- Face OMS	180 t
	- Face availability	6 hours

TABLE 3

7W MAIN GATE DEVELOPMENT

Depth of Cover	240 m	
Heading Height	2.54 m	
Heading Width	4.27 m	
Heading Length (max.)	2744 m	
Gradient	2° across heading	
Roadway Supports	- Hollybank Rectangular 0.15 m x 0.15 m RSJ + 2 legs (pin joints) - lagged and strutted - set at 0.9 m intervals	
Drivage Machine	- Dosco Dintheader - 12 m Bridge Conveyor	
Coal Clearance	- 920 mm Gate Belt - Huwood TB 80/120, 90 kW Drive with 13 m loop take up	
Materials Transport	- Clayton Battery locomotive + Pikrose flat deck cars	
Ventilation	- 37.5 kW Engart fan. (forcing) - 910 mm smooth Flexiduc - 4.7 m^3/s at face	
Performance	- Average 7.3 m/shift	
Manpower	Heading Machine	4
	Mechanic	1
	Electrician	1
	Materials supply	3
	Supervision	1
		10
	Manpower Limit 15	

TABLE 4

10E LONGWALL ADVANCING FACE - LINGAN MINE

Depth of Cover	600 m
Seam Height	1.8-2.0 m (+0.3 m following stone)
Face Length	222 m
Panel Length	2530 m
Pillar Width	60 m
Gradient	8°
Shearer	- Anderson Strathclyde DERDS. AM300 (225 kW) - Eicotrack haulage - Powered cowls - 1.2 m dia. drum with pick face flushing - 0.71 m web - cutting speed max 8 m/min, average 4 m/min - Bretby Cable Handler
AFC	- Halbach & Braun twin inboard 26 mm chains, with closed bottom pans, 1 metre flight spacing - 105 kW in line drive units at Main Gate and Tail Gate
Stage Loader	- As for AFC except single drive and 0.5 metre flight spacing. Headend on monorail
Face Supports	- Hemscheidt 2 leg (360 t) shields with powered forward cantilever
Roadhead Supports	- 4 leg Dowty chocks across both gate roadways (4 in each gate)
Roadway Supports	- Tail Gate - 127 mm x 114 mm 3 piece arches plus solid wood chock on pillar side and solid wood chock plus 1.5 m solid pack on goaf side - Main Gate - Arches (as TG) plus solid wood chock on pillar (low) side and solid wood chock plus 1.1 m wide pump pack on goaf side. (50% Astrocem, 50% Astrobent; 2.5:1 liquid/solids ratio, 20 min setting time.)

TABLE 4 (Cont'd)

10E LONGWALL ADVANCING FACE - LINGAN MINE

Tail Gate Ripping	- Drilled and fired, and loaded by Eimco 21 side discharge loader onto Python chain conveyor direct onto face AFC. Taking 2 m rock. Rock drill suitable for mounting on Eimco. Suspended from arches when not in use.	
Main Gate Ripping	- Drilled and fired, and loaded by Webster loader onto stage loader.	
Main Gate Dint	- Webster loader onto stage loader	
Materials Handling	- by endless rope haulage in TG, diesel locomotives in MG both using GMT materials flat cars, and by compressed air Becorit monorails over last 50 m in both gates	
Gate Conveyor	- 920 mm wide belt, Huwood TB 80/120 drives, 15 m loop take ups	
Power	- 1100 v with control boxes, transformers and power pack all monorail mounted	
Ventilation	- 16.5 m^3/s target quantity on face - methane emission 28-30 m^3/t (15-20 m^3/t in earlier faces) - methane drainage practiced in TG with 43 m long holes (9 m casing) at 55° inclination set at 24 m intervals. Extracting 0.17-0.21 m^3/s methane. System in operation 2 1/2 years and has vastly improved conditions on face, especially in TG - BMI monitors set at 1.25% CH_4 cut off (TG)	
Face Manpower/Shift	- Shearer	2
	- AFC/rams	2
	- Supports	2
	- AFC/stage loader	1
	- TG Ripping	4
	- TG Pack	4
	- MG Pack	5
	- MG Ripping	4
	- Stage loader	1

TABLE 4 (Cont'd)

10E LONGWALL ADVANCING FACE - LINGAN MINE

	- Methane Drainage	3
	- Mechanic	1
	- Electrician	1
	- Supervisor	1
		31
Performance	- Average 2 -3 shears/shift - 3-8 hr shifts/day - Face availability 6 hours - Average shift output 1100 t	

TABLE 5

7W LONGWALL ADVANCING FACE - LINGAN MINE
(with Main Gate Advance Heading)

Depth of Cover	620 m
Seam Height	1.9 m
Face Length	222 m
Panel Length	1240 m
Pillar Width	60 m
Gradient	8°
Shearer	- Anderson Strathclyde AM300, DERDS (225 kW) - Eicotrack - 0.71 m web, 1.2 m dia. drum with pick face flushing
AFC	- Halbach & Braun twin inboard 26 mm chain with closed bottom pans, two in-line drives
Face Supports	- Hemscheidt 2 leg shields (142)
Roadhead Supports	- Dowty 4 leg Buttress chocks (3 in TG) - At MG, one Dowty 4 leg chock + 1 Dowty 6 leg Buttress chock + 2 Dowty 4 leg Pack hole supports with rear cantilever bars
Main Gate Roadway	- 3 piece U section yielding arches - At face end, crowns supported by 4 leg in-line sliding beam support bridging face AFC. 4 Arch legs taken out. Double wood/dirt packs built.
Tail Gate Ripping	- Drilled and fired, loaded by Atlas Copco (56 kW) loader onto short AFC to face AFC - Wooden chocks at roadsides - 2 piece arches
Main Gate Advance Heading	- Dosco Mk IB Roadheader - Bridge conveyor - 10 m ahead of face - Set 4.9 m x 3.66 m 3 piece yielding arches - Face side above seam bolted. 2-2 m bolts every 0.6 m - Webster boom loader for clean-up at face end

TABLE 5 (Cont'd)

7W LONGWALL ADVANCING FACE - LINGAN MINE
(with Main Gate Advance Heading)

	- Ventilation 37 kW Engart Fan + Wet dust filter and 0.76 m ducting - methane 0.25% - performance 2 arches/shift cutting horizontal floor	
Main Gate Dint	- Haus Herr Dinter loading onto stage loader	
Manpower	- as per 10E face plus, in advance heading:	
	Dosco Roadheader	3
	Webster loader	1
	Electrician	1

TABLE 6

1W LONGWALL RETREATING FACE - PHALEN MINE

Depth of Cover	350-400 m
Seam Height	1.8 m coal and 0.6 m shale/coal
Face Length	150 m
Panel Length	1380 m
Pillar Width	80 m (upper), 60 m (lower)
Gradient	12°
Shearer	- Anderson Strathclyde AM500 DERDS - Powered cowls - max. speed 8 m/min - limited to 4 m/min - drum diameter 1.5 m with pick face flushing - 0.7 m web - Eicotrack haulage
AFC	- Dowty twin inboard 26 mm chain AFC with closed bottom pans. Two drive units, in line with coal sizer on AFC at MG end with separate drive. AFC TG Drive has short drive frame - AFC side discharge onto Dowty beam type stage loader (0.91 m wide)
Stage Loader	- 15 m overlap
Gate Conveyor	- 1.07 m wide, FSW drive unit (90 kW)
Face Supports	- Dowty 2 x 550 t shields wth Dowval electronic control and face lighting
Tail Gate Support	- Roadway driven by Dosco Mk 2B and supported on 3 piece arches - Powered support in Roadway comprised 2 - 4 leg Buttress chocks with extended canopies with one single offset leg over the face AFC. Support chocked on top to suit arch profile
Main Gate Support	- Roadway support - Rectangular section Hollybank supports - Powered support in Roadway comprises 2 - 550t 2 leg shields with rigid canopies extended to catch roof girders at face ends

TABLE 6 (Cont'd)

1W LONGWALL RETREATING FACE - PHALEN MINE

Power	- 1100 v with all control boxes, transformers and power packs (3) suspended on mono-rail	
Materials Handling	- Endless rope haulages with Pikrose cars in 1W (Scharf monorail intended for 2W)	
Ventilation	- 28 m^3/sec with 0.3% CH_4 in MG and 0.6% in TG	
Manpower	- Shearer	2
	- AFC Rams	1
	- Face Supports	1
	- Tail Gate	2
	- Main Gate	2
	- Console	1
	- Mechanic	1
	- Electrician	1
	- Supervisor	1
		12
Performance	- 3-4 strips normally - Face production limited by outbye conveyors until Cable Belt commissioned - Average day (2 shifts) 2000 t -1W Face - Best day (3 shifts) 7000 t - 1E Face - Best week 30000 t - 1E Face	

TABLE 7

2W MAIN GATE DEVELOPMENT DRIVAGE - PHALEN MINE

Depth of Cover	450 m	
Roadway Height	2.8 m	
Roadway Width	4.3 m	
Roadway Length	1650 m	
Gradient	12° across heading	
Roadway Shape	Inclined rectangular	
Road Support	- Hollybank rectangular 0.15 m x 0.15 m RSJ + 2 legs (pin joint) - lagged and strutted - set at 0.9 m intervals	
Drivage Machine	- Westfalia VME Roadheader - Curved gathering and discharge conveyor - 120 kW cutting head with external sprays - canopy over operator - Girder setting device	
Coal Clearance	- 30 m long Bridge Conveyor - 1.07 m wide Gate Conveyor	
Materials Transport	- Scharf Monorail with endless rope drive	
Ventilation	- 90 kW Engart fan forcing 4.7 m^3/s with 37.5 kW auxiliary exhausting system with spiral ducting	
Manpower	- VME	5
	- Conveyor	1
	- Materials	2
	- Monorail	1
	- Supervisor	1
		10
	- Electrician and mechanic on call - Manpower Limit 15	
Performance	- Best shift - 13 m - Average shift - 7.2 m - Average day - 20 m - Average week - 100 m	

Note: Dosco Mk IB averaged 4-5 m/shift in coal and 1-2 m/shift in harder rock
Dintheader averaged 100 m/week

TABLE 8

A14 SINGLE ENTRY RETREAT FACE - WISTOW MINE

Depth of Cover	310 m
Seam Height	2.4 m
Seam Height Mined	2.1 m
Face Length	35 m
Panel Length	1000 m
Pillar Width	55 m
Gradient	Approximately level to 1 in 14
Roadway Width	5 m
Shearer	- Anderson Strathclyde AM500 DERDS. (300 kW) - Pitcraft Haulage - 0.76 web - 1.68 m dia. drum with pickface flushing and venturi ventilation - forward attack picks plus heavy duty radial picks on back face of drum - powered cowls - fully outboard 1.3 m ranging arms - Pitcraft water boost pump to give 7 Mpa (1000 psi) (Fire range at 3 Mpa) - Lindley Hydraulic tank for shearer on stage loader and oil piped along face and shearer - cutting speed 9.8 m/min - m/c cutting on wedge from end to end - Perard Cable Handler
AFC	- 118 kW 2 speed, Head End Drive, Winster 90° Gearbox with integral chain tension and goaf side chain drive to coal sizer on face AFC - Mining Supplies 9 m radius Gemini ramped drive frame - Non driven return end - Twin outboard 22 mm chain with flight bars at 0.5 m spacing - Heavy duty underplated line pans welded (including furnishings) in sets of 3 - Spill plates (1 m high) including Pitcraft ventiliation duct (0.28 m^2)
Stage Loader	- Beam type, 23 m long - 112 kW in-line Drive, direct drive (no fluid coupling)

TABLE 8 (Cont'd)

A14 SINGLE ENTRY RETREAT FACE - WISTOW MINE

	- H.D. return end bolted to same base plate as AFC drive to maintain delivery position and assist advance - Twin outboard chain with flights at 0.65 m centres - UMM chain tensioner - 0.6 m high beam plates - no overlap with gate conveyor - fixed delivery position, articulation only
Face Supports	- Dowty 4 x 450 t chock shields (22) with push buttom electro-hydraulic control at 1.5 m spacing - Gullick Dobson (2) Power packs remotely situated in intake with 50 mm intake and 64 mm return flexible hoses down gate to face supports - Face sprags fitted to chocks
Roadway Support	- 0.15 m x 0.15 m RSJ + 2 legs (pin jointed) meshed and strutted at 0.9 m centres + Bolts - Powered supports at Roadhead, 3-Dowty 4 x 280 t chock shields with extended canopies
Gate Conveyor	- FSW Modular In-Seam Conveyor - Automatic Loop take-up (100 m belt) and Beltreel Station - PIAB belt tensioner set at max. 2 t, min. 1.2 t - Integral tail end receiving section - U trough, no rollers with four side staking rans to position in roadway for belt alignment - Conveyor controlled and tension monitored from surface - 1.06 m wide belt
Power	- Twin 1100v power supplies, 1 to shearer, 1 to AFC, stage loader and inbye fan - Transformers outbye in main roadway - Twin contactor gate end boxes, control console and booster fan mounted on stage loader so automatically moved with stage loader

TABLE 8 (Cont'd)

A14 SINGLE ENTRY RETREAT FACE - WISTOW MINE

Ventilation	- Two auxiliary systems, Primary to face ducting & blind end, Secondary to rear of roadhead chock. - Primary, 90 kW Engart forcing fan in outbye intake through 760 mm lay flat ducting to 37.5 kW Engart fan on stage loader to lay flat through ventilation duct through face to blind end. 'Rocket' tube at stage loader fan to collect ducting as face retreats. - Secondary, 90 kW Engart forcing fan in outbye intake through 610 mm lay flat ducting to rear of roadway powered support. - Primary $6m^3/s$. - Secondary 2.5 m^3/s. - Monitors - - Flow in blind end - TX 130 Alarms at less than 4.5 m^3/s. - BMI at #7 Chock - Alarm 0.8% CH_4 Power Cut off at 1.25% CH_4. - Manual Reset - BMI at outbye end of roadway. - CO monitor (10 ppm alarm via MINOS) - Smoke detector end of roadway. - Fan Vibration - Methane Emission 6-7 m^3/t.
Materials Handling	- Battery or diesel locomotive with Pikrose flatbed material cars.
Face Manpower/Shift	- Shearer 2 Supports/Rams 1 Face End 1 Supervision 1 5 Mechanic and Electrician on call. Manpower Limit 12.
Performance	- Face retreats 150 m/week on average. - 20 strips/shift average (1500 t ROM). - Max 27 strips in 1 shift. - Best week (A10's) 26,928 t. - Face OMS - 240 t.

TABLE 8 (Cont'd)

A14 SINGLE ENTRY RETREAT FACE - WISTOW MINE

Installation/Salvage	- Face change 2 weeks.
	- Installation using loco transport - 1 week.
	- Pre salvage, face bolted & meshed.
	  - 6 rows - 2 m long bolts at 0.9 m intervals.
	  - Set with 2 Gopher machines at 40/hr.
	- EIMCO 913 FSV used to drag supports off face.
	- Face Support preparation 2 days.
	- Face Support removal 1 day.
	- Salvage - total 1 week.

TABLE 9

A15 SINGLE ENTRY DEVELOPMENT - WISTOW MINE

Depth of Cover	305 m.
Heading Height	2.44 m.
Heading Width	4.57 m.
Heading Length	1000 m.
Gradient	Level.
Roadway Support	- Hollybank Rectangular 150 mm x 150 mm R5J + 2 legs (pinpointed) at 0.9 m spacing lagged with wire mesh. - Row of 6 - 1.8 m full column resin 24 mm rebar bolts set between girder settings. 4 vertical bolts at 1 m centres 2 angled (30°) bolts, 1 over each side. Fitted with plates. - Drilled with compressed air 'Gopher' stoper behind Heliminer - Immediate roof 1.2 m fossilized shale. 1.8 m weak shale. strong shale.
Drivage Equipment	- BJD Heliminer cutting 3.66 m wide. - 12 m bridge conveyor. - girder setting brackets.
Coal Clearance	- 1.07 m belt conveyor. - boltless structure. - FSW modular in seam 112 kW Drive with 100 m capacity loop belt reel and automatic belt tension.
Materials Transport	- Diesel & Battery locomotives & Pikrose flatbed materials cars.
Ventilation	- 90 kW Engart forcing fan with 760 mm lay flat ducting. - 37.5 kW Engart exhausting fan overlap at face, 13 m overlap. - Primary 6 m^3/s.
Manpower	- Heading crew 6 (includes bolting, belt, pipes, ventilation, cables & track extension).
Performance	- 150 m average per week (15 shifts). - Best shift 20 m. - Best week 170 m.

TABLE 10

DEEP HARD/PIPER PARTIAL EXTRACTION - SHERWOOD MINE

Depth of Cover	600 m
Seam Height	3.1 m
Heading Width	7.35 m
Heading Length	continuous
Gradient	1 in 25
Pillar Width	7.3 m
Partial Extraction	approximately 50%
Roadway Support	- 150 m x 127 mm RSJ with radiused ends to fit cut cusp, Hollybank type with pinjointed legs at each end of middle set by girder clip. Beam 5.7 m long. - Strutted and lagged (mesh) - 1.3 m centres - Rock bolts 2.3 m long, full column resin 24 mm rebar intended to be set (7 No.) between supports - Drilling equipment not capable of completing cycle within machine cycle. Being improved - Ultimate target is to dispense with arches
Drivage Machine	- Dosco In Seam Miner 3000. (Twin unit stacked machine) (180 kW cutting power) complete with 3 hydraulic roof drills, staker rams, and girder setting device and Dowty roof canopy behind jib
Coal Clearance	- 22 m machine conveyor (chain) onto 1.37 m wide belt conveyor - FSW modular in-seam conveyor with belt reel station, automatic loop take up (96 m) - 90 kW drive - Tail end positioned and spragged by four horizontal hydraulic rams.
Materials Handling	- GMT Bo-Bo Battery locomotive and GMT flat materials cars to back of machine. Manhandled from there.
Ventilation	- Primary - 2 x 37.5 kW Engart fans in series forcing air through fibreglass ducting (0.91 m) to rear of machine

TABLE 10 (Cont'd)

DEEP HARD/PIPER PARTIAL EXTRACTION - SHERWOOD MINE

	- Secondary - 1 x 37.5 kW Engart fan exhausting air from ducts on cutting head; discharging through Joy microdyne wet dust filter. 50 m ducting length. - Primary 6 m^3/s Secondary 3 m^3/s - BM1 Methane Unit on machine	
Manpower	- Machine Materials Supervision	3 3 1 7 * =
	*includes extension of pipes, track, ventilation and conveyor - 15 man limit	
Performance	- Best shift 16 m - Best week 120 m (15 shifts) - ISM cutting rate 4.6 m/hr - Drove 22 m radius curve (inside) through 48° and 22 m straight drivage on 6.4 m wide girders in 3 weeks - Potential drivage rate on rock bolts only is 200 m/week	

TABLE 11

133's SINGLE ENTRY RETREAT FACE - SHERWOOD MINE

Depth of Cover	600 m
Seam Height	3.4 m
Height Mined	3.1 m
Face Length	55 m
Panel Length	1200 m
Pillar Width	50 m
Gradient	1 in 25 along entry; 1 m 20 to blind end
Shearer	- BJD B59 DERDS (225 kW) - 1.53 dia drums with pick face flushing - 0.68 m web - powered cowls - max cutting speed 9.8 m/min - Pitcraft haulage - Bretby cable handler
AFC	- NCB Heavy duty side discharge with Winter 90° Gearbox and 120 kW motor - Twin inboard 22 mm chain, 1 metre flight spacing - Pitcraft furnishings incorporating 0.26 m^2 ventilation duct
Stage Loader	- NCB Heavy duty 120 kW in line drive with twin outboard chains and half metre flight spacing - Coal sizer with standard AFC gearbox and 120 kW mounted on stage loader - stage loader discharge fixed onto conveyor tail end (articulation only)
Face Supports	- Gullick 4 x 370 t chock shields with rigid canopies and face sprags. 1.5 m centres - Blind end chock fitted with anti flushing plate (attached to canopy) overlapping lower anti flushing plate (attached to return end of AFC) - Electronic control fitted but not operational awaiting computer card suited to Bi-Di operations - outbye Hauhinco pumping station with H.P. supply 45 mm steel + screw fittings and LP return 64 mm victaulic pipe to face.

TABLE 11 (Cont'd)

133's SINGLE ENTRY RETREAT FACE - SHERWOOD MINE

Roadway Supports	- 150 mm x 127 mm x 3.1 m x 5.4 m flat top Hollybank arches (3 piece) at 1 m centres, meshed and strutted
Roadhead Supports	- 2 - Dowty 4 x 280 t Roadhead supports with extended powered forward cantilever to support crowns in face entry area. Spans 6 crowns.
Gate Conveyor	- FSW modular in-seam conveyor - 112 kW drive, 1.2 m wide - 96 m automatic loop take up - return end located and held by 4 horizontal staker rams - conveyor belt stored automatically as AFC/stage loader retreated
Ventilation	- Primary - 90 kW Engart forcing fan through 900 mm lay flat ducting connected through to blind end - Secondary - 2 x 37.5 kW Engart fans forcing air through 900 mm lay flat ducting to rear of ribside roadhead powered - support Primary - minimum 5 m^3/s, actual 6 m^3/s Secondary - minimum 3 m^3/s - Waste drainage through pipe left behind in abandoned drivage at 50 m intervals, old gate walled off at 20 m intervals CH_4 capture low - Monitoring - BA5 velocity (blind end) - Alarm 5 m^3/s - BM3 Blind End) - BM3 Chock #3) Alarm 0.8% CH_4 - BM3 Gate/Face) Cut off 1.25% CH_4 - Typical Return - 0.57% CH_4
Power	- 1100 v - Transformers outbye district - Gate end boxes and console, lighting and monitoring mounted onto stage loader

TABLE 11 (Cont'd)

133's SINGLE ENTRY RETREAT FACE - SHERWOOD MINE

Face Manpower/Shift	- Shearer	2
	- Chocks	1
	- Rams	1
	- Roadhead	1
	- Stage loader/console	1
	- Supervision	1
		7
	9 man Limit Mechanic and electrican on call	
Performance	- Best shift - 1100 t saleable - Best week - 8000 t sal. (15 sh.) - Face availability 5.5 hrs - Best advance/day 27 shears 18.4 m	
Installation	- 2 weeks - chock installation (36 + 2) - 3 days	
Salvage	- not yet attempted but 2 week transfer planned	

TABLE 12

Eickhoff ESA Type Machines

Model	Cutting Power (kW)	Cutting Range (m) Min.	Max.	Remarks
60-L	60	1.4	3.2	Standard
60-2L	60	1.1	1.4	Low Height
60-L-2W	60	1.8	2.7	Steep seam (2 haulages)
60-K	60	1.8	4.2	High cutting Tilting body
150-L	150	1.8	3.5	Standard
150-K	150	1.8	4.2	High cutting Tilting body
300	300	n.a.	n.a.	D.C. Haulage Essentially a short single ended shearer due December '88.

Note: Maximum cutting speeds.
ESA 60 3 m/min. or 6 m/min.
ESA 150 6.5 or 8.0 m/min.

TABLE 13

87/70 Longwall Face - Zolder Mine

Depth of Cover:	729-777 m
Height Mined:	2.30 m (includes 0.75 m stone)
Face Length:	279 m (Shearer) + 18 m Stables
Panel Length:	450 m
Gradient:	9° along face
Shearer:	Eickhoff EW 170L 170 kW 1100 V Single ended shearer 1.8 m diameter drum 0.75 m web Eicotrack haulage Pick face flushing (phased) 52 picks
AFC:	Halbach & Braun EKF3 Twin inboard 26 mm chains 2 x 120 kW, TG in line, MG 90° drives Chain speed 0.78 m/s, flight spacing 1 m
Stage Loader	2 x 63 kW in line drives Twin outboard 18 mm chain 1.19 m/s chain speed Coal sizer Total length (into stable) 56 m Fixed delivery onto gate conveyor All electrical panels on stage loader No overlap
Face Supports	Klockner Becorit 4 x 110 t chock shields at 1.5 m centres Powered forward canopy Remote Hauhinco pump station
Tail Gate Stable	Length 12 m - in line with face Machine ESA 60-L (60 kW) 1000V 1.70 m dia. drum om 750 mm arm 0.75 m web Eicotrack haulage on face AFC phased pick face flushing Support - Link Bars & Hydraulic props - 2 Klockner 4 x 110 t chocks

TABLE 13 (Cont'd)

Tail Gate Roadway	2 piece arches set on wood and dirt packs (solid). Ripping 10 m from face. Haus Herr A1010 loader
Main Gate Stable	Length 9.5 m, 10 m ahead of face Machine ESA 60-L (60 kW) 1000 V - 1.7 m dia. drum on 250 mm arm - 0.75 m web - Eicotrack haulage on DMFO twin curved centre discharge conveyor - phased pick face flushing Support - link bars and props
Main Gate Roadway	2 piece arches set on wood and dirt solid packs with access to face between goaf side packs (2). Ripping 10 m behind face line. Salzgitter HL80 Loader
Gate Conveyor	1.1 m wide with 2 x 63 kW drives Belt speed 2.25 m/s Automatic loop take up Delivers into 60t spiral bunker which feeds 1.3 t mine cars.
Ventilation	Homotropal - 35 m^3/s Methane emission 12 m^3/t Methane drainage recovers 6 m^3/t Ventilation dilutes 6 m^3/t 1.5 kW auxiliary forcing fans to ventilate tailgate corner and stable holes Venturi air movers in stables Automatic methane detectors on face, and in tail gate
Materials Handling tailgate	Dusterloh hydropull 3000 rope monorail in
Manpower/Shift (3 m/day advance)	2 shift coal, 1 shift maintenance

	1	2	3
Shearer	2	2	2
Rams/supports	8	8	1
Tail Gate Stable	4	4	-
Main Gate Stable	4	-	-
Tail Gate Packs	-	3	-
Main Gate Packs	3	-	3

TABLE 13 (Cont'd)

	1	2	3
Mechanics	5	5	6
Electricians	2	2	3
Stage Loader/conveyor	3	3	3
Materials	7	7	5
Gate Rippings	4	4	3
Equipment Extension	-	-	8
Supervision	8	8	7
	50	46	41

Performance	Average 900 t Saleable/Shift
Face Opening	ESA 60 7 m wide (props and bars) 7 m/shift
Roadway Heading	ESA 60 7 m wide (arches) 4 m/shift